DOCUMENT RESUME

ED 040 558	EC 006 112
AUTHOR	Pronovost, Wilbert; And Others
TITLE	The Development and Evaluation of Procedures for Using the Voice Visualizer as an Aid in Teaching Speech to the Deaf. Final Report.
INSTITUTION	Boston Univ., Mass.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-6-2017
PUB DATE	Aug 67
GRANT	OEG-1-6-062017-1588
NOTE	178p.
EDRS PRICE	EDRS Price MF-$0.75 HC-$9.00
DESCRIPTORS	*Articulation (Speech), *Aurally Handicapped, Consonants, Deaf, Equipment Evaluation, *Exceptional Child Research, Instructional Materials, *Material Development, Speech Improvement, Speech Therapy, *Visible Speech, Vowels

ABSTRACT

A prototype voice visualizer was constructed and a program of instructional materials designed to teach discrimination of minimally paired vowel or consonant sounds. Two groups of 24 deaf children with poor articulatory ability received instruction twice weekly for 4 months; also, a group of eight deaf children with good speech participated in five sessions. Listener ratings indicated both the consonant and vowel groups improved most markedly in the first month. The consonant group improved more, but improvement in articulatory proficiency was not accompanied by corresponding improvement in word intelligibility. The additional group of eight showed improvement in both areas. The visualizer was reportedly easily operated and presented no technical problems. (Author/JD)

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FORM 0801

ED040558

FINAL REPORT
Project No. 6-2017
Grant No. OE-1-6-062017-15888

The Development and Evaluation of Procedures for using The Voice Visualizer as an aid in Teaching Speech to the Deaf

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U. S. DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE

Office of Education
Bureau of Research

EC006112E

ED0 40558

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THE DEVELOPMENT AND EVALUATION OF PROCEDURES FOR USING THE VOICE VISUALIZER AS AN AID IN TEACHING SPEECH TO THE DEAF

Wilbert Pronovost
Delmar Anderson
Robert Lerner
Linda Yenkin

Boston University

Boston, Massachusetts

August 31, 1967

The research reported herein was performed pursuant to a grant from the Office of Education, U. S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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ACKNOWLEDGMENTS

The researchers acknowledge with appreciation the cooperation of the children of the Boston School for the Deaf who participated in the project, their parents, and the Sisters of St. Joseph who staff the school and provided space for the experimental teaching.

SUMMARY

Purpose. This study was designed to develop a prototype Voice Visualizer and a manual of teaching materials and procedures, and to evaluate these procedures by means of an experimental program with deaf children.

Methods. The prototype model of the Voice Visualizer was constructed. A program of instructional materials for vowel sounds and for consonant sounds was designed using words which were "minimally paired" for discrimination of two vowel sounds or two initial or final consonant sounds. The teaching program was conducted for one half hour twice weekly for four months with two groups of twelve deaf children each. All children had hearing losses of 90 db (ISO) or more in both ears, poor articulatory ability, and intelligence within normal limits. The effectiveness of the Visualizer and the teaching program was evaluated through tape recordings of test words and phrases made at the beginning of the study and after each of the four months of the program. Listeners judged which of two utterances of the same test word by a child represented better speech. Other listeners were used to measure word intelligibility. Complete case study information was obtained for each child on the assumption that changes in speech proficiency might be related to specific factors in the case history. As the study progressed, it was decided to add an "Advanced Speaker's" Group, with relatively good speech for deaf children, as a basis of comparison. Eight children participated in five sessions with the Visualizer during a two and one half week period.

Findings. Both the consonant and the vowel groups improved their speech as a result of the program. Both groups showed the greatest improvement at the end of the first month in the experimental program. The consonant group improved more than the vowel group; however, improvement of judged articulatory proficiency was not accompanied by a corresponding improvement of word intelligibility. The "Advanced Speaker's" group improved both in intelligibility and in terms of listener preference.

The prototype Voice Visualizer was found to be easily operated by teachers and children; no technical problems requiring maintenance occured. The teaching materials and procedures appeared effective for the Visualizer and the population of children used.

Conclusions. The Voice Visualizer is a compact, stable, portable unit which can be used in a classroom to supplement other approaches to the teaching of speech to the deaf. A teaching program using minimally-paired words is appropriate. The Visualizer is likely to be most effective in motivation of speech improvement for short periods of time, for refinement of vowel and consonant articulation, and with children who have reasonably intelligible speech accompanied by misarticulations of consonant sounds.

Recommendations. It is recommended that continuing research with the Voice Visualizer be conducted through its use by classroom teachers of the deaf to supplement their regular classroom speech program and by clinicians involved in individual work with the communicative skills of deaf children. Exploratory research with young deaf children in using the Voice Visualizer for speech development is also indicated. The results of this study also indicate the need for a variety of research designs to study the extent and manner by which deaf children can learn to use any visual display of acoustic information to monitor speech production.

I. INTRODUCTION

Interest in the use of visual displays of speech, which could be used to teach speech to the deaf, has existed for many years and has increased in recent years. Historical developments and results of recent studies have been summarized by Pronovost (14). The latest technical developments and issues related to the use of visual feedback of acoustic information for teaching speech to the deaf were discussed in depth at a Conference on Speech Analyzer Aids for the Deaf held at Gallaudet College, Washington, D.C., June 14-17, 1967 (5).

Authorities agree that deaf individuals need sources of information about speech to replace the deficient auditory system. Although some attempts have been made to develop tactile systems which transmit patterns of sound vibration through the fingers (Pickett 13) and systems which display patterns of speech-mascular movements on an oscilloscope screen (Brannon 4), the majority of the units used to teach speech to the deaf have been visual displays of acoustic parameters of speech such as vocal intensity level, pitch level and intonation patterns, stress and temporal patterns, and consonant and vowel spectral patterns. In using these various instruments, a deaf individual must translate the acoustic information through his visual perceptual system into some type of information for kinesthetic monitoring of speechmuscular movements. The manner and extent to which a deaf individual can do this is not known. Some authorities feel that the differences between the auditory and visual perceptual processes preclude such a translation of information. Others feel that the need of the deaf for information about their speech production requires that all sources of potential information be utilized. This feeling is reinforced by those who report clinical impressions of success with certain visual display units. However, those who report some success are unable to indicate the contribution which the visual information makes to the observed changes in speech.

Among the problems of using visual feedback equipment, particularly as perceived by teachers of the deaf, have been those of technical operation and maintenance. Until very recently, the electronic aids have required considerable technical ability to operate the numerous control-dials which needed continual adjustment. In addition, frequent repairs were necessary. Teachers, frustrated by their lack of technical knowledge and frequent equipment breakdowns, were reluctant to use the speech-analyzer aids available to them. Recent developments in electronic circuits and miniaturization and stabilization of components, have now resulted in several units which are practical for use by teachers if their value and the procedures for using them could be demonstrated.

Among the electronic devices which permit deaf children to monitor their speech visually and instantaneously is the Voice Visualizer. The unit was originally developed from a polar analyzer circuit by Robert Lerner (9). Its use in a pilot study by Pronovost (15) showed promise in improving the articulatory proficiency of deaf children, particularly the voiceless and voiced fricatives, and in reducing the number of consonant omissions in words. The results were similar to those reported by Searson (16). Improvements of articulatory ability and intelligibility of deaf children reported by Kopp and Kopp (7) gave further indication of the potential of instantaneous visual feedback as an approach to developing speech in deaf children.

Voice Visualizer Patterns

The Voice Visualizer presents discrete and discriminable patterns for the vowels [i] [ɛ] [a] [o] [u] and the consonants [m] [l] [r] [f] [v] [s] and [z], as shown in Figures 1, 2 and 3. Plosive consonants produce abrupt "splashes" of light on the Visualizer screen. While patterns of different plosive consonants cannot be discriminated from each other, it is possible to distinguish plosives from nasal or fricative consonants having a similar place of articulation, such as the labial consonants [b] and [m] or the alveolar consonants [t] and [s]. Although the patterns are most easily identified when a speech sound is sustained in isolation, it is possible to identify readily a vowel pattern in the stressed position of a monosyllabic word, or a consonant pattern in the initial or final position of a word. Self-monitoring of speech by deaf children is therefore most effective when using single word units in which the articulation of only one phoneme in the word is monitored.

The distinguishing features for each vowel and consonant pattern are essentially similar from speaker to speaker - man, woman or child. While slight differences occur between speakers, any speaker who matches the model of a good speaker (e.g., a teacher), while using his optimal pitch range, will be producing a speech sound that is identifiable as the intended phoneme.

Purposes. The purposes of the current study were to:

1. Develop a prototype Voice Visualizer specifically for use as a visible speech unit for the deaf.

2. Develop materials and procedures for using the Voice Visualizer for monitoring the production of specific vowels and consonants in spoken words and phrases.

3. Undertake trial use of the Voice Visualizer with two groups of

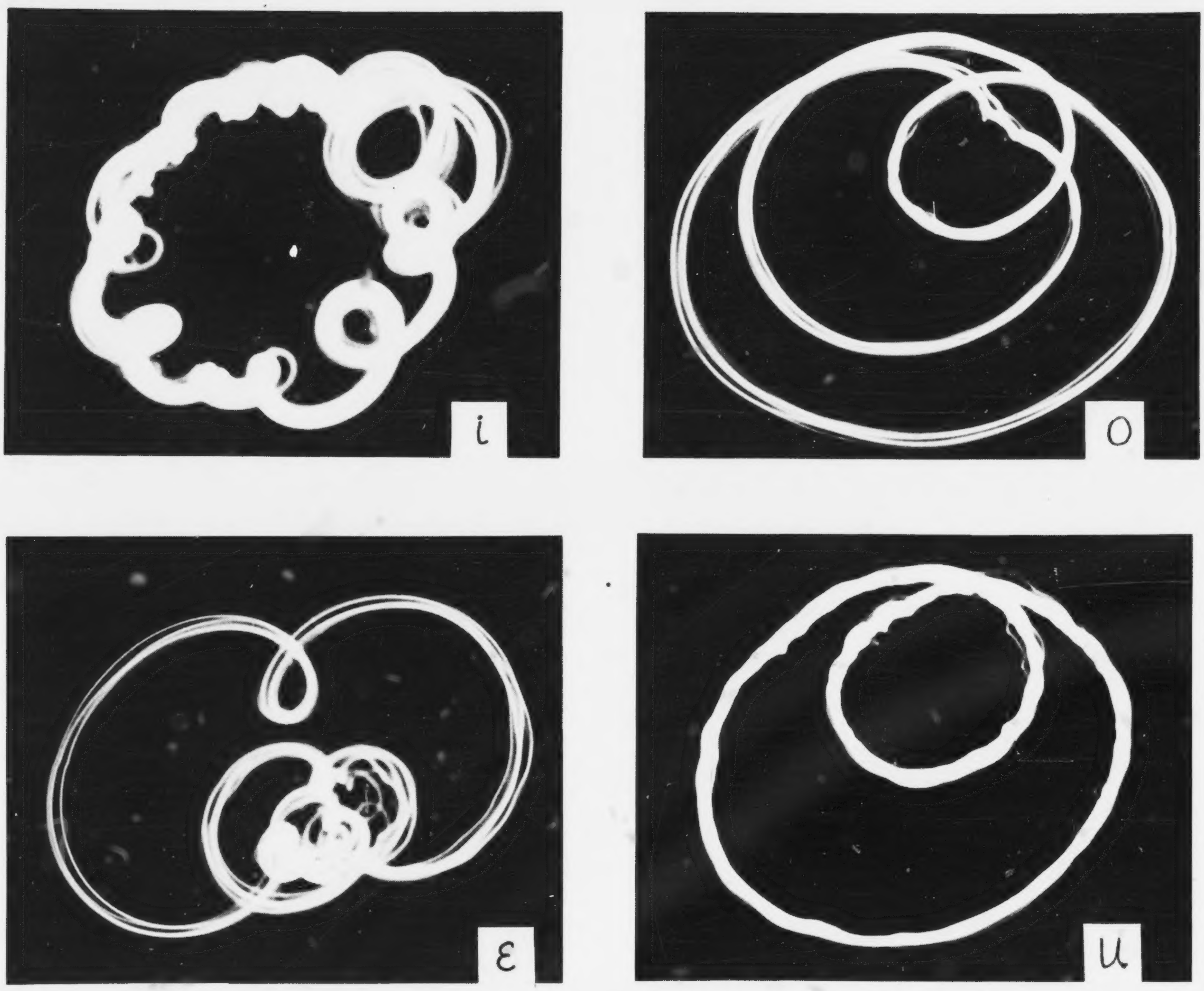


Figure 1. Patterns of [i, ϵ, o, u]

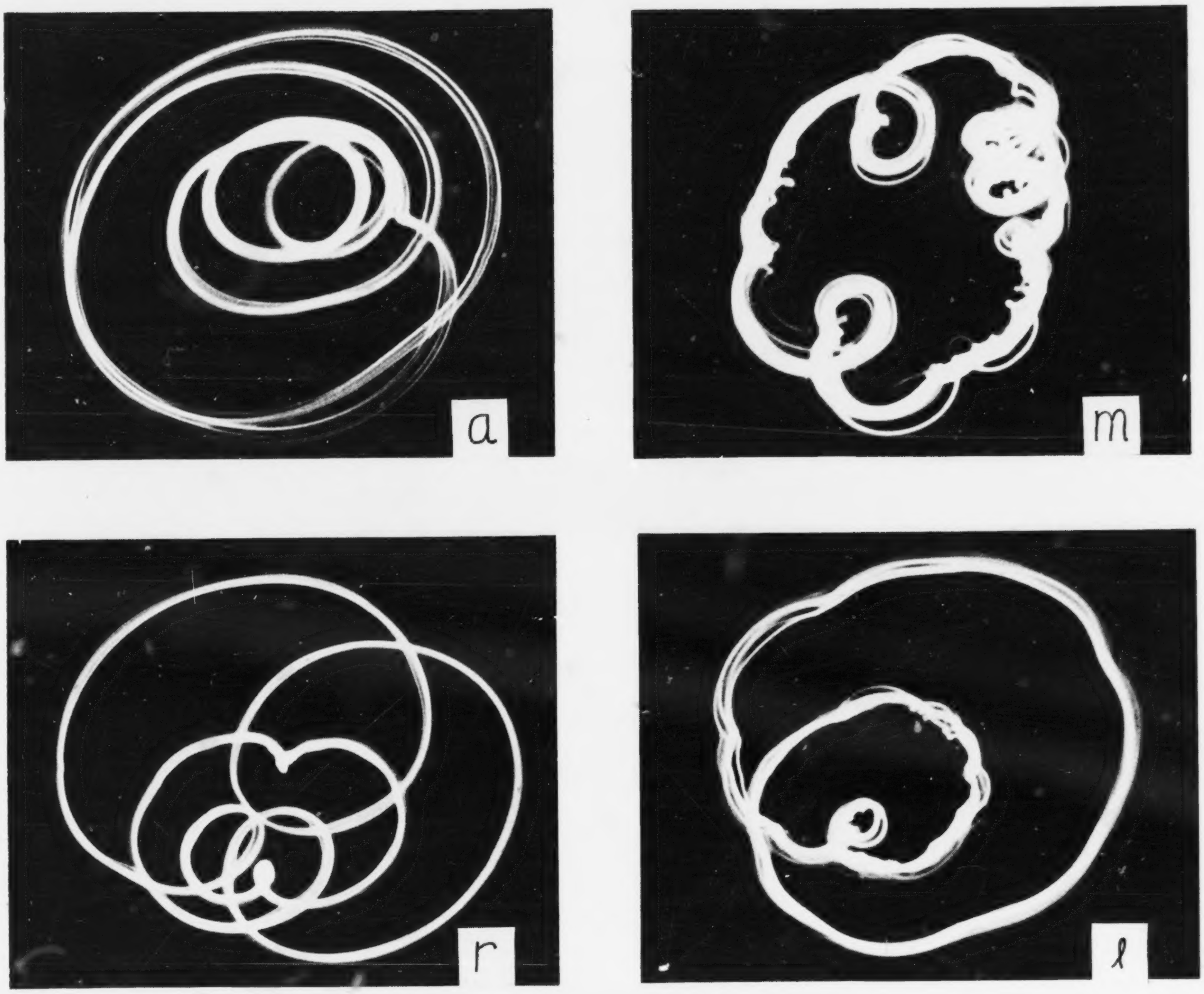


Figure 2. Patterns of [α, m, r, l]

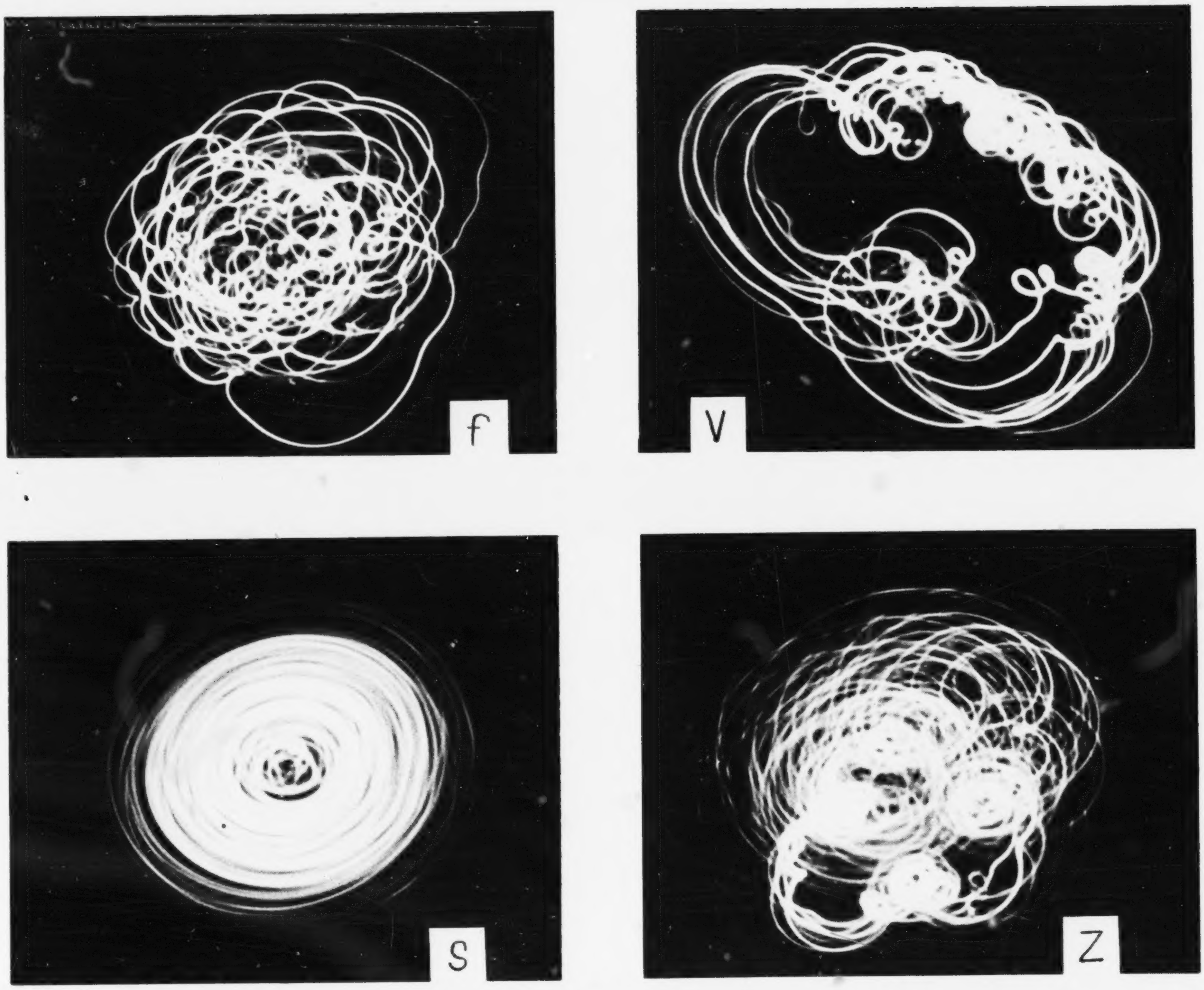


Figure 3. Patterns of [f, v, s, z]

deaf children, one designated the vowel group, the other the consonant group, and report changes in articulatory proficiency.

4. Compare the changes in articulatory proficiency of the deaf children with other information about their auditory, intellectual, and visual-perceptual behavior and environmental back-background, in order to make inferences about the use of the Voice Visualizer.

5. Present circuit information, drawings and photographs which will permit future construction of units of interested users.

6. Present a manual of instructions and materials for use by teachers of the deaf.

II. METHOD

Preparation of the Equipment

Engineering refinements and construction of the prototype model were undertaken simultaneously with the development of the teaching materials. Engineering refinements included the addition of an audio output to provide high gain and high quality sound in order to provide each child with instantaneous auditory as well as visual feedback of his own speech for self-monitoring. Detailed technical information about the units if presented in the RESULTS section (pp. 26-41) of this report.

Preparation of Teaching Materials and Procedures

On the basis of the previous pilot study (Pronovost 15), it was decided to prepare teaching materials that would involve a child's speaking of word pairs which would be phonemically similar except for the two contrasting vowel or consonant sounds. Vowel sounds to be contrasted were in the medial position of monosyllabic words (men-moon). Consonants to be contrasted occurred in the initial or final position of monosyllabic words. The words used during the experimental teaching program are essentially those appearing in the Manual to be found in the RESULTS section (pp. 42-64) of this report.

An exploratory teaching program was conducted during the development of the materials in order to refine the materials and teaching procedures. Children who would not be included in the experimental program participated in several sessions with the research teacher. Photographs of the research teacher's production of the speech sounds to be constructed were placed on opposite sides of the Voice Visualizer screen. Below each model pattern, a flashcard containing the printed word and a pictorial representation was placed. As the child spoke the two words, he was instructed to observe the Visualizer screen and attempt to match his speech patterns for the two contrasting sounds with the model patterns adjacent to the Visualizer screen. The child was instructed to prolong slightly, the initial or final consonant, or the medial vowel sound in order to observe his own pattern.

The arrangement of the room in which the teaching program was conducted is shown in photograph of Figure 4. The research teacher was seated next to the child, and visual communication between teacher and child was carried through the mirror. This physical arrangement reduced the child's tendency to turn toward the teacher and away from the Visualizer screen. The room was located in the Boston School for the Deaf, Randolf, Mass., where all sessions with the children were held.

Although any portion of the teaching session was organized around word pairs for two contrasting speech sounds which could be monitored on the Visualizer, the research teacher used an individualized multi-sensory approach to develop a child's articulatory proficiency. The approach used auditory, tactile, and lipreading clues as well as explanations and demonstrations of the accurate production of each speech sound. The Visualizer was used primarily to provide instantaneous feedback of the accuracy of a child's production of the speech sound.

Because the ultimate goal of speech training for deaf children is articulatory proficiency in connected speech, an attempt was made to develop meaningful language units in the form of short stories from which word pairs containing two of the contrasting sounds could be drawn. A short story featuring words containing [m] and [b] in initial and final positions was written and presented to four deaf children. The story and word pairs used for contrast on the Voice Visualizer may be found in Appendix A. Much time was needed to explain even superficially to the children the most important language concepts in the story, and many of the words used with the Visualizer remained meaningless to them. In view of the time which would have been required to make the language in this and subsequent stories meaningful, and the relatively small amount of time which would have remained in each session for visual self-monitoring of meaningful words drawn from the stories, the attempt to base practice words on story materials was abandoned.

Using Moser's One Syllable Words (Moser 11, 12) as guides, several kinds of word lists were compiled for use in devising materials and gathering data: 1.) a basic word list of 20-40 simple picture words (words which could either be represented or described by a picture) for each speech sound, 2.) lists of minimally paired words for all combinations of the five vowels and seven consonants used. 3.) minimal pairs for sounds often confused by the deaf, e.g. [b] - [m], [s] - [t], or often omitted by the deaf, e.g. [s] [r], 4.) two syllable words or phrases containing

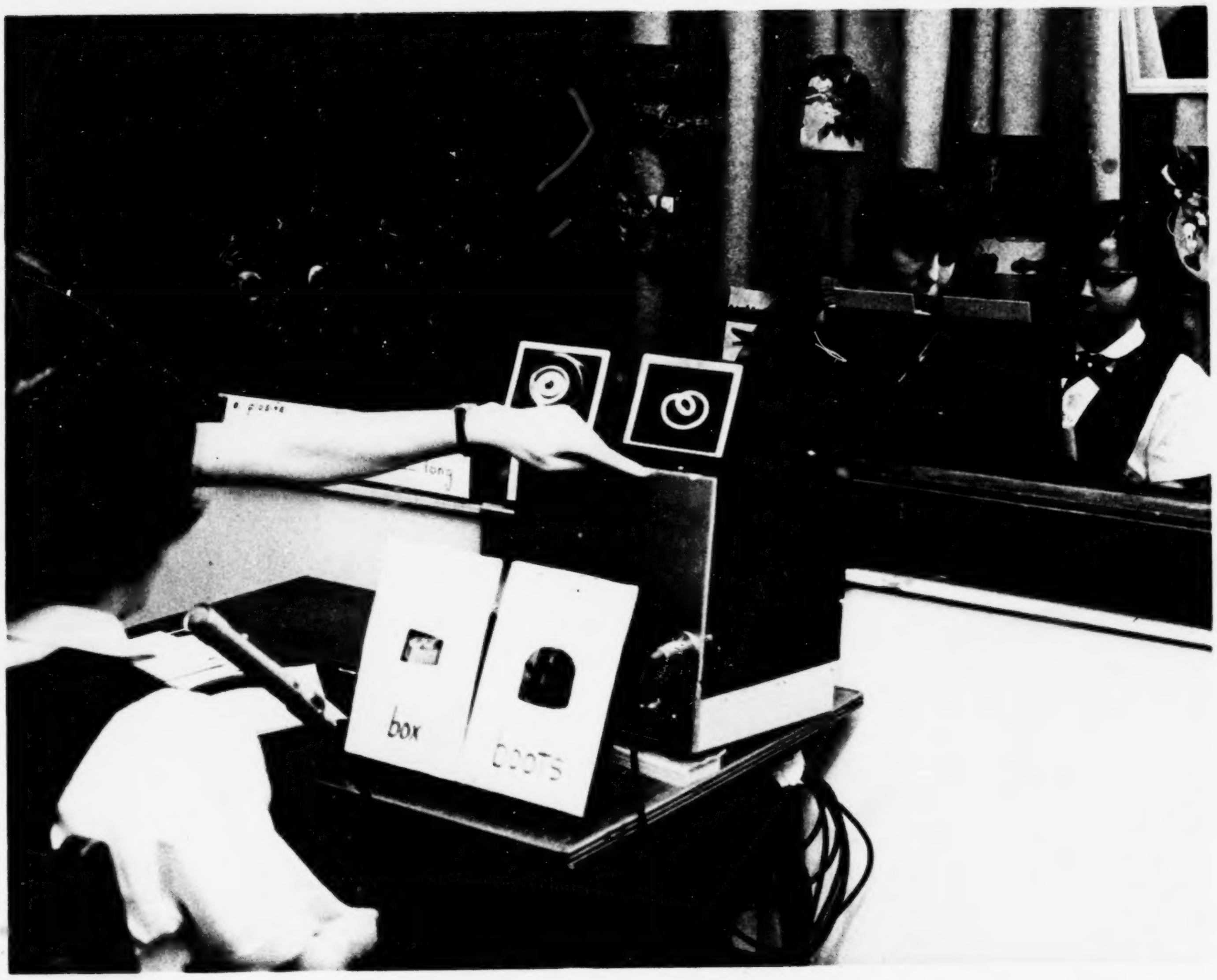


Figure 4. Photograph of a child and research teacher in a teaching session showing arrangement of equipment and materials. The Voice Visualizer unit in this photograph is the original pilot model. The photograph was taken prior to completion of prototype mode.

two contrasted sounds, (hello, red bow, snowmen). Selection was based on the probability that the deaf children would be familiar with the word and that the word could be represented pictorially as well as in printed form. A picture of each word (two men for the word "men") was cut from a magazine or mail-order catalogue and mounted on a 5" x 7" flash card. The word was printed above the picture. During the exploratory teaching sessions it became evident that some deaf children had limited comprehension as well as speaking vocabularies and that word meaning would sometimes have to be explained before the word could be used for speech practice.

The exploratory teaching sessions also revealed the necessity for developing a sequential series of contrasting speech sounds which would progress from easier to more difficult speech sounds and contrasts according to both the physiology of speech production and the discriminability of the Visualizer patterns.

Each set of materials for a contrasting pair of speech sounds was developed as a "frame" of teaching materials. The sequence was necessary so that children could progress through a series of relatively successful experiences. Since the Voice Visualizer provides instantaneous feedback of errors as well as accuracies of speech production, it was important to structure the sequence so that children would experience success as often as possible in order to avoid discouragement. It was also found desirable to prepare separate sequences of frames for the vowels and for the consonants to simplify the visual perceptual task involved in self-monitoring.

Experimental Teaching Procedures

A series of frames for vowels or consonants was presented to 12 deaf children in a Vowel Group or 12 deaf children in a Consonant Group during two sessions weekly over a four-month period.

The sequence of frames for the vowel group presented the word pairs in the following order:

1. [m-ɑ]
2. [ɑ-i]
3. [ɑ-u]
4. [u-ɛ]
5. [ɝ-ʔ]
6. [ɛ-ɑ]
7. [ɛ- o]
8. [o- i]
9. [ɑ- o]
10. [o- u]
11. [i- ɛ]
12. [i- u]

The sequence of frames for the consonant group was:

1. [m-b]
2. [m-f]
3. [p-f]
4. [f-s]
5. [θ-n]
6. [s-t]
7. [f-v]
8. [s-z]
9. [f-z]
10. [z-b]
11. [m-r]
12. [m-l]
13. [l-r]

The consonant [m] was included in the first frame for both the vowel and consonant groups since it had been observed that deaf children could produce the sound successfully in the first session. The frames for [æ-ɔ] in the vowel group and [θ-n] for the consonant group were included as control frames in which the visual feedback from the Visualizer was utilized.

Each frame of contrasting sounds consisted of about 20 minimally paired words on flashcards, plus some additional words and phrases containing one or both speech sounds of the frame. In addition, four sets of review phrases containing various combinations of speech sounds were constructed, one set for the experimental vowels, one for the control vowels, one for the experimental consonants, and one for control consonants.

Prior to the first speech-practice sessions, a visual pattern-matching session was conducted to determine that the children could identify and match visual patterns, including those of the Visualizer. The children were given a series of four visual pattern-matching tasks. These tasks included matching of large and small geometric figures, large and small complex circular patterns, large and small photographs of Visualizer patterns of vowels and consonants, and photographs of Visualizer patterns and actual patterns produced on the Visualizer screen by the research teacher. The instructions and score sheets for these tasks may be found in Appendix B. All children met the task criteria prior to beginning the first speech practice session.

The first sessions were designed to: 1) teach the child to focus attention on the Visualizer screen, 2) teach discrimination of grossly different visual patterns in words, in the research teacher's and in the child's own speech, 3) teach slight prolongation of the monitored sound in a word while retaining a normal rhythm and rate in speaking the other phonemes.

A basically similar procedure was followed in all sessions. Photographs of the Visualizer patterns of the two sounds to be contrasted were placed on either side of the Visualizer screen, and the sound patterns illustrated vocally by the research teacher. Materials were placed on the rack beneath the Visualizer screen and the research teacher illustrated the concept of rapid alternation of minimal pairs, drawing attention to the sound patterns being contrasted. During illustration, care was taken to prolong only the experimental sounds and to maintain as nearly as possible a natural speech rhythm.

Each child progressed from one frame to the next in the sequence after spending at least one session but no more than two sessions on one frame. If a child had a relatively high degree of success in one frame on his first exposure to it, he moved on to the next frame in the next session, after only a brief review. If a child was moving very quickly through a particular frame and seemed to be losing interest for lack of challenge, the session was shortened accordingly. In some instances, certain frames were skipped in order to present a child with two contrasting sounds which might be particularly helpful to him.

A portion of each session at the beginning and/or at the end, was devoted to review of previous frames. Though no rigid division of time was adhered to, the general procedure allotted the first 5-10 minutes to a review of the last frame completed, the next 10-15 minutes to the current frame under study, and the last few minutes to a quick review of two or more sounds with which the child was proficient.

In the last month of the experimental period the review phrases were introduced for use at the end of each session. Each child was asked to monitor all experimental sounds to which he had been exposed as they occurred in the review phrases.

For those children who had difficulty adjusting their rate of speech to allow for prolongation of the sound to be monitored, exercises to teach awareness and control of duration were undertaken. "Long" sounds [ɑ, i, u, o] were contrasted on the Visualizer with "short" sounds [p,t,k] and the child was asked to discriminate visually between long and short in the teacher's and his own speech. Flashcards illustrating three degrees of duration were posted within the vision of the child and were used as reference guides as needed.

Throughout all the sessions, an attempt was made to develop finer discrimination and more consistent self-monitoring with less dependency upon instruction and reinforcement by the research-teacher.

Procedure for teaching the control sounds was similar to that for the experimental sounds, and materials for the control sounds corresponded to material used with the experimental sounds. The child was asked to contrast the two control sounds (for either vowel or consonant group), using the mirror to monitor mouth movements rather than the Visualizer to monitor sound patterns. One or two initial teaching sessions and two to four review periods spaced over the rest of the whole experimental period were devoted to contrast and refinement of the control sounds. Review phrases, each containing several presentations of the control sounds were introduced for review of the control pairs in the last month of the experimental period.

Subjects

Subjects for the experimental program included 24 deaf children, ages 7-10 through 9-11, divided into two groups - Group I, Vowel Group, 12 children, Group II, Consonant Group, 12 children. The minimal age of 7 years was selected in order to minimize the effect of any developmental physiological factors, since many normally hearing children do not develop complete proficiency for all phonemes until age 7. Subjects were chosen who had poor vowel quality and/or poor consonant articulation on the basis of a picture articulation test and an interview with the research teacher, but who had revealed at least minimal receptivity to speech training in the opinion of the classroom teacher. Subjects were required to have an average hearing loss of 90 db (ISO) or more in both ears at 500,1000, and 2000 Hz. These criteria of hearing sensitivity were used to insure inclusion in this phase of the project of only those children with the least amount of residual hearing. The final criteria for inclusion as a subject was mental ability within normal limits as revealed by results of the battery of school tests, school progress reports, and the teacher's rating scale (Appendix C).

Case study information was obtained for each child and may be found in Appendix D.

Sources of information were:

1. School folder: including background information on the child, school progress reports, medical and physiological reports from outside sources, results of intelligence tests and correspondence relating to the child.

2. Teacher: including teacher rating scales on behavior, language level, speech, and response to auditory stimuli with amplification and informal interviews with the teacher about the child. Teachers also completed the Pupil Behavior Rating Scale developed by Bower (3).

3. Parent: including a form to be filled out by each family and an interview with the research-teacher in the home, giving the parent's or parents' impression of how the child communicates at home, the degree to which his speech is intelligible, what his interests are, and what his usual behavior pattern is, in addition to supplementary background information. Information from the parent also provided the interviewer with a general impression of the atmosphere in the home.

4. Tests: the Ayres Space Test (1) and the Frostig Developmental Test of Visual Perception (6) were administered to assess visual perceptual ability as it might be related to a child's

ability to discriminate the Visualizer patterns.

No attempt was made to use a control group in this study. The number of variables which might affect each subject's level of articulatory proficiency at the beginning of the study, and any changes in articulatory proficiency during the study, were felt to be considerable and uncontrollable at the present stage of research with visual feedback of acoustic information as a procedure for teaching speech to the deaf. The study was therefore planned with each child as his own control, with inferences about the contribution of the Visualizer to be made from the series of tape recordings and the case study information.

"Advanced Speakers" Group

During the experimental program with the vowel and consonant groups, the research staff questioned whether the Visualizer might have value in refining the speech of deaf children who were the more intelligible speakers, in contrast to the population chosen for the experimental program. Therefore, the supervising teacher at the school for the deaf was asked to indicate children who were judged to have the "best" speech. The research teacher verified that the children had reasonably intelligible speech with misarticulations of consonants and few vowel distortions. Eight "advanced speakers" were selected for participation in a brief experimental period of instruction with the Visualizer. The children selected ranged in age from C.A. 5-5 to C.A. 12-7. Average hearing loss was moderate to severe. Ages and audiograms are given in Appendix E.

The children were seen bi-weekly for two and one-half weeks; each session was approximately twenty minutes in length. The first session was devoted to 1) recording each child's speech, 2) presenting the visual pattern-matching tasks and 3) orienting the child to the unit.

The original consonant test words and phrases used with the vowel and consonant groups were modified so as to eliminate the control sounds and to add representative words for each experimental vowel (see Appendix F,2 p. F). During the tape recording of the initial test, each child's articulatory errors were identified by the research teacher. All children successfully completed the visual pattern-matching tasks.

The second, third and fourth sessions were devoted to instruction and practice with phonemes which were noted to be misarticulated in the initial speech analyses, and only frames which dealt with those sounds were used. It was observed in the initial speech analysis that the vowel quality of the "advanced speakers" was generally good and that the phonemes which were distorted were fricative consonants. The frames which were used most often with this group were: [s-t], [f-v], [s-z], [z-v], and [m-b]. Two children used the [r-l] frame; one child used the [i-u] frame.

The fifth session was devoted to a brief review of the sounds studied and to recording the children's speech while each experimental speech sound was monitored with the Visualizer, using the same procedure as described for Tape 4 of the experimental groups (see p. 15).

Evaluation Procedures

Evaluation of the experimental program was undertaken by an analysis of tape recordings of the children which were made periodically during the program, through anecdotal records maintained by the research staff throughout the program, and by an analysis of the case study information.

Tape recordings were made of each child speaking the words and phrases of an especially constructed test. Separate tests were constructed for the vowel and consonant groups.

From the basic word lists of simple picture words five test words and two alternates were selected for each of the twelve experimental sounds. The criteria for selection were: 1) probability that the words were familiar to the subjects in order to avoid problems of word meaning associated with infrequently spoken words, and 2) the necessity for providing different environments for each experimental sound to allow evaluation of the relative improvement made in each sound in different contexts.

Five test words and two alternates were subsequently selected for the control vowel, and seven test words for the control consonant, using the same procedure as before, but with the additional criterion that each test word of the control sound be minimally paired with one of the five test words for each of the experimental sounds.

Two sets of test phrases were then constructed, one set containing words using the experimental and control vowels and an equivalent set for the consonants. The phrases were in simple language-construction and could be represented or described by a picture. Each set of phrases contained three of the test words for each sound.

Pictures representing or describing each of the test words and phrases, were selected or drawn and mounted on oak tag sheets with the appropriate word or phrase printed above.

Test words and phrases are given in Appendix F.

Tape recordings of each child were made with the appropriate test four times. Tape 1 was recorded prior to the initial teaching sessions. Tape 2 was made approximately one month into the experimental period. Tape 3 was made after approximately two and one-half months of the experimental program. For this tape recording the child was instructed to watch the Voice Visualizer as he spoke the words and phrases. Photographs of the patterns of those sounds with which the child was familiar were placed on the Visualizer rack. The child was reminded to watch the Visualizer screen at random intervals during the testing session. Tape 4 was made at the close of the experimental period, approximately four months after the initial session. During this test session the five photographs of vowel patterns or the seven photographs of consonant patterns were placed in rows beside the Visualizer. As each test was presented, the research teacher selected the photograph of the sound being monitored and placed it adjacent to the Visualizer screen. (No photograph of the control sounds was presented).

The periodic recordings made during the instructional sessions with the Visualizer were employed as one method of analysis. Each child was recorded saying the test words at various times during his training, before working with the Visualizer, five weeks later, five weeks after that, and then a final recording. The recordings made before and during the training sessions were used to make a master tape for analysis. As an example, the same word said before the training session was compared with the same word said a few weeks later. Therefore, the Master Tape consisted of the same word said at two different times during the training session. The task of the listener was therefore, to select which response represented better speech. The randomized Master Tapes were made in the following manner: two Wallensak recorders were channeled into one Ampex 703 recorder. On tape recorder number one would be placed, for example, the words recorded before the training session and on tape recorder number two, the words recorded after the first five-week segment of the training session. A random order of presentation would then follow. The final Master tapes then consisted of paired responses of the same word said by the same child at various times during the project.

Listeners There were two criteria for the selection of listeners. One is that they have normal hearing, with some knowledge of phonetics. There were fifteen listeners used in the project, ranging from ages nineteen to twenty-six. The training session consisted of listening to ten paired responses selected from the tapes. These ten paired responses were chosen because the experimenters believed they represented noticeable differences between responses. There was 100% agreement between the fifteen listeners used in the project. It was therefore believed that there was an agreement of criteria before the listening project began.

Instruction to Listeners:

> You will hear two productions of each of the words in the list. Your task is to choose the response that more nearly represents a spoken production of that word. Mark 1 if you believe the first Superior, mark 2 if you think the second is Superior, and if you hear no improvement in speech production, mark the column Same.

The final tapes were presented to listeners in groups of five each. The Master Tapes were played in a free-field listening condition where the subjects' responses were 60 db louder than the background noise. The listeners were instructed not to discuss or look at each other's papers.

III. RESULTS

Vowel Group

Results from Pre-Test to First Testing Period. The listening tapes contained each subject (child) speaking in random order the same word (said) prior to training with the Visualizer and five weeks after training. Five listeners responded to all twelve children. Each listener recorded his preference by indicating which of the two speech productions he thought contained more elements of speech. The listeners' responses were pooled for each subject. Therefore, 30 paired words, spoken by twelve speakers were listened to by five listeners. A chance score indicating no group improvement would be 50% of the 1,800 listener preferences. A total of 1,642 of the choices were words spoken after work with the Visualizer. 93 were marked "the same", and 75 preferences were spoken during the pre-test. Therefore, 91% of the listeners' selections were words said after working with the Voice Visualizer.

Results from the Second Testing Period to the Third Testing Period. The same procedures were used between test sessions two and three. Test session three occurred five weeks after the second testing session. Results were analyzed in the same fashion. The 1800 listener preferences were as follows: 1067 preferences were spoken during the third session. A total of 227 was considered the same, and 526 were spoken during the second session. Fifty-nine per cent of the listener preferences was therefore spoken during the third testing period.

TABLE I

Response Preference After Each 5-week Period - Vowel Group

Total Responses	Number of Responses from each Comparison			
	First Period	Second Period	Judged Same	Per Cent Improvement Over Last Test
1800	75	1962	93	91%
	Second Period	Third Period		
1800	526	1067	207	59%
	Third Period	Final Period		
1800	594	1104	102	61%

Results from the Third Testing Period to the Final Test. Of the 1800 listener preferences in this comparison, 1,124 were responses given during the Final test. 604 were words spoken in the third testing session and 122 were judged as the same. Therefore, 60% of the listener preferences occurred during the last testing period.

Control Words. Five words containing the sound [æ] were also included in the test words. These words were also a part of the lesson plan, but were not practiced with the Visualizer. Twelve subjects speaking five words were listened to by five listeners, resulting in 300 possible listener preferences. Between the first test period and second test period listeners preferred 187 responses spoken during the second test, 46 responses from the first, and 67 responses were marked the same. Therefore, 62% of the listener preferences were words spoken during the second session.

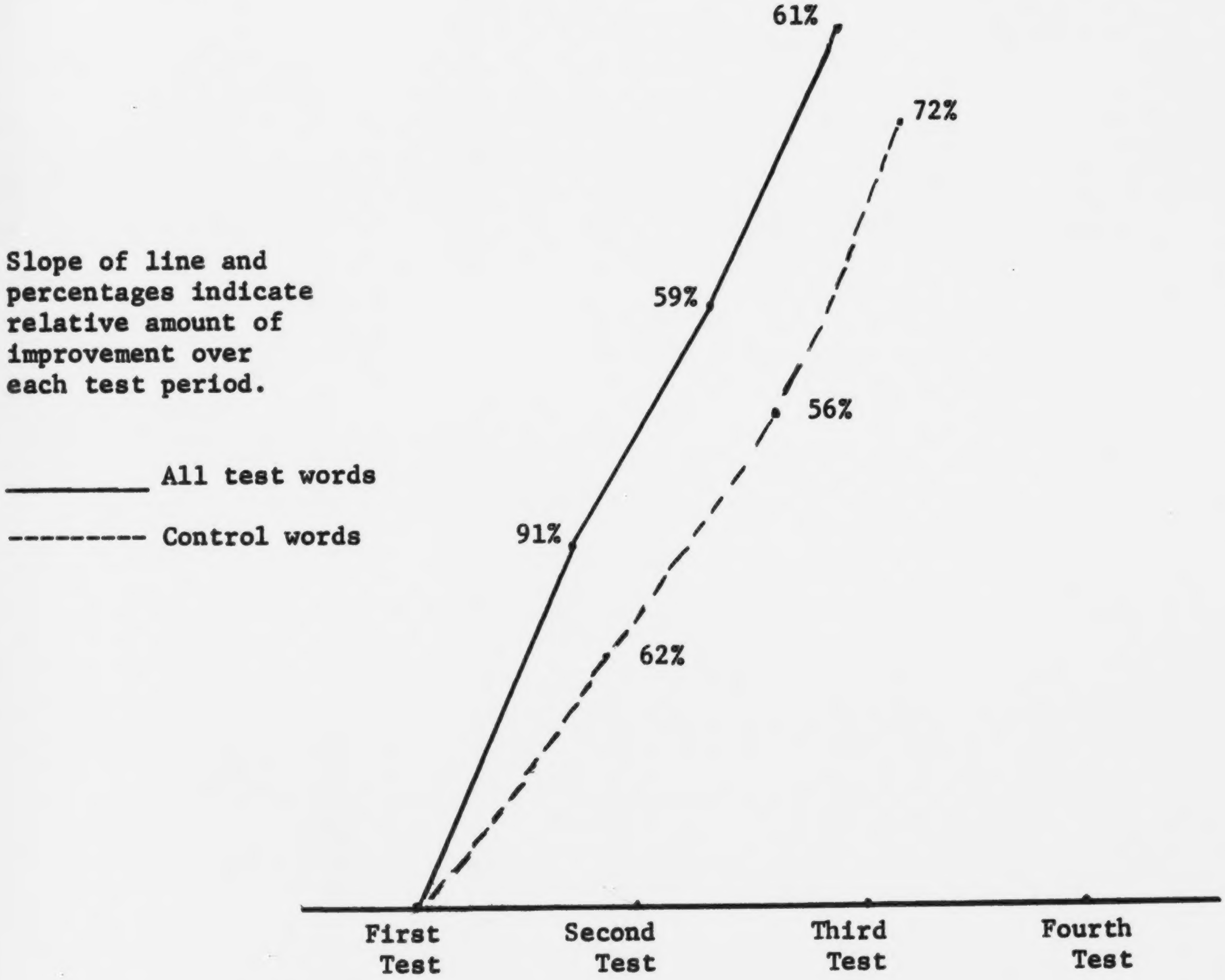


Figure 5. Amount of Improvement over Previous Responses as judged by Listener Preferences.

Between sessions two and three, 168 preferred responses were from the third test, 88 from the second test, and 64 were judged the same.

Between sessions three and four, 218 preferred responses were from the fourth test, 27 from the second test, and 55 were judged the same.

TABLE II

Per Cent Improvement over previous test with control words and all test words - vowel group

	Between Test One and Two	Between Test Two and Three	Between Test Three and Four
All test words	91%	59%	61%
Control words	62%	56%	72%

From the above table, it can be noted that the initial improvement was not as great with the control words; however, during the final tape, the control words appeared to improve more.

Intelligibility as a Measure of Improvement. Two sets of five listeners who were not familiar with the speech of the deaf and had not been previously exposed to the test words listened to the original tapes. The listeners were requested to write down the words they heard. The tapes from all subjects of the vowel group were then randomly presented to the listeners. The results indicated a very negligible improvement in intelligibility: two per cent intelligibility in the initial test, two per cent in the second, three per cent in the third, and six per cent in the final test.

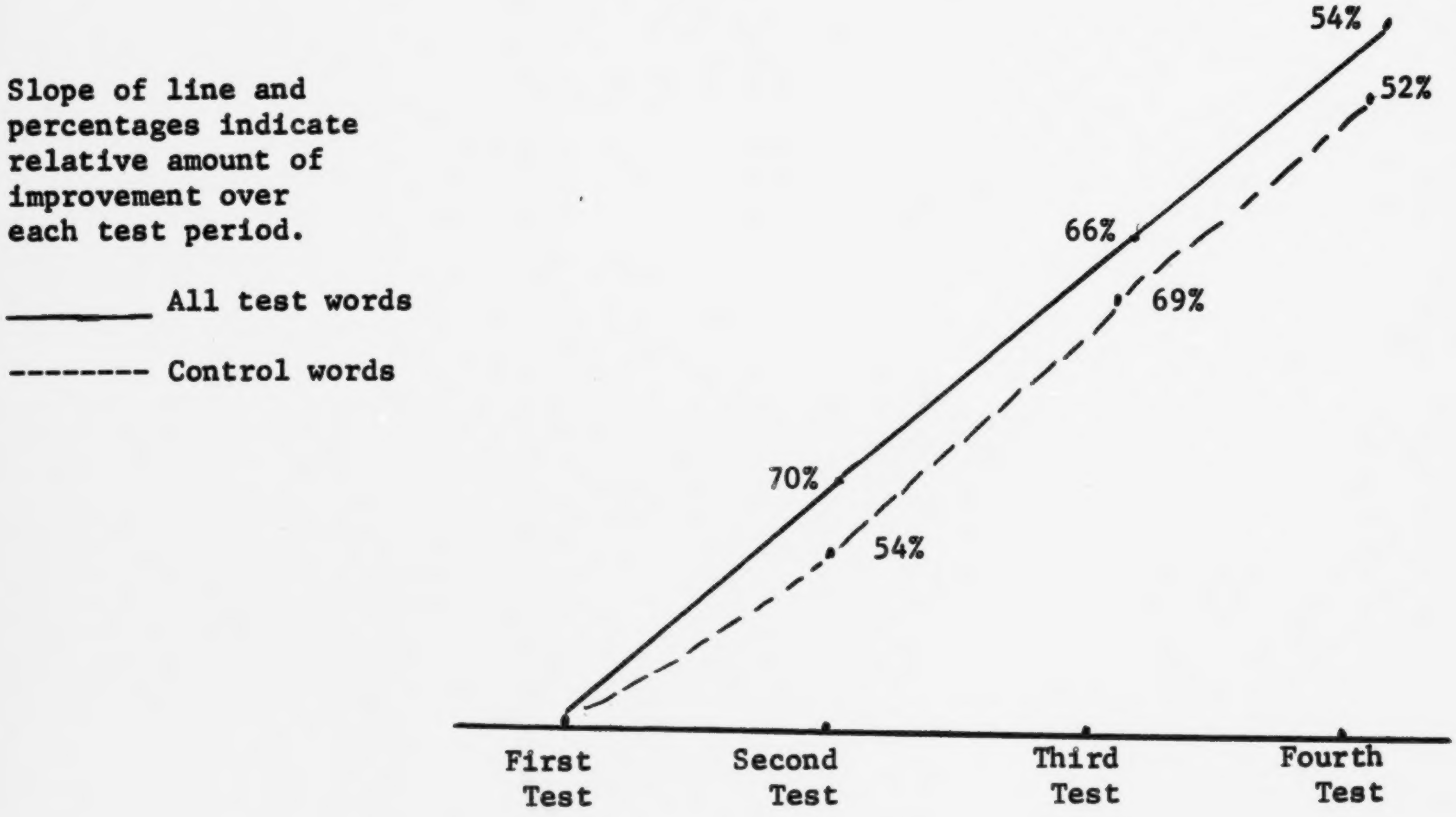
Consonant Group

Results from the Pre-test to First Testing Period. The consonant tapes were analyzed in the same way as were the vowel tapes. Five listeners listened to twelve speakers saying 42 words, resulting in 2520 listener preferences. Between the first test and the second test, 1765 preferred responses were spoken during the second test, 218 were from the first session, and 537 were judged the same. There was therefore a 70% preference of ~~responses spoken~~ after work with the Voice Visualizer.

TABLE III

Response Preference After Each 5-week Period-Consonant Group

Total Responses	Number of Responses from each Comparison			
	First Period	Second Period	Judged Same	Per Cent Improvement Over Last Test
2520	218	1765	567	70%
	Second Period	Third Period		
2520	481	1726	314	66%
	Third Period	Final Period		
2520	688	1360	472	54%



Slope of line and percentages indicate relative amount of improvement over each test period.

Figure 6. Amount of Improvement over Previous Responses as judged by Listener Preference - Consonant Group.

Results from the Second Testing Period to the Third Testing Period

Between the second taped session and the third taped session, there were 1726 preferred responses from the third session, 481 from the second tape, and 314 were judged the same. This represents a 66% preference over the previous test.

Results from the Third Testing Period to the Final Test. Between the third and fourth tests, 1360 responses were from the fourth test, 688 were selected from the third test, and 472 were judged the same. A 54% preference was shown for the final test.

Control Words. Seven words containing the consonant [n] were included in the test words. These words were also a part of the lesson plan, but were not practiced with the Visualizer. Twelve subjects speaking seven words were listened to by five listeners, resulting in 420 possible listener preferences. Between the first test period and the second test period, listeners preferred 219 responses spoken during the second test, 107 responses from the first, and 94 responses were marked the same. Therefore, 55% of the listener preferences were words spoken during the second session.

Between sessions two and three, 282 preferred responses were from the third test, 138 from the second, and 81 were judged the same.

Between sessions three and four, 221 preferred responses were from the fourth test, 115 from the second test, and 84 were judged the same.

TABLE IV

Per cent improvement over previous test with control words and all test words - Consonant Group.

	Between Test One and Two	Between Test Two and Three	Between Test Three and Four
All test words	70%	66%	54%
Control words	54%	69%	52%

Once again, it can be noted that the initial improvement was not as great with the control words: however, during the second 5-week period there was almost equal improvement.

Intelligibility as a Measure of Improvement. The intelligibility of the consonant group follows the same procedure as that of the vowel group. In the initial test the subjects were found to be 4% intelligible, 6% in the second, 12% in the third, and 18% in the last. This represents an improvement of 14% during the course of the project.

"Advanced Speakers'" Group

The analysis of the eight advanced speakers followed the same procedure as that of the consonant and vowel groups. The results of the pre and post tests can be seen in the following table:

TABLE V

Comparison of percentage of listener preference and intelligibility scores among the three groups after the first training period.

Percentage of Listener Preference in the Second Test:		Amount of Improvement in Intelligibility between the First and Second Tests:	First Test	Second Test
Consonant Group	70%	Consonant Group	4%	6%
Vowel Group	93%	Vowel Group	2%	2%
Advanced Speakers'	98%	Advanced Speakers'	18%	53%

Clinical Observations

The detailed case study information may be found in Appendix D. An analysis of the case study data reveals a homogeneous group of children as far as the initial criteria of hearing loss, intelligence, and articulatory proficiency are concerned. All children had severe hearing losses, had intelligence within normal limits, and poor articulatory proficiency for vowels or consonants. Other case study information revealed various environmental or emotional factors which might have contributed to poor speech and poor performance in the study by many of the children.

The results of the Ayres and Frostig tests of visual perception could not be interpreted meaningfully. Although these two tests were selected as including visual perceptual tasks related to self-monitoring of speech on the Visualizer, it was found that the scores on the two tests did not correlate with each other, nor was any relationship between test scores and other case study information apparent.

Observations of speech behavior during the sessions were reported regularly by the research teacher and randomly by the principal investigator and research associate. These observations revealed variability in the behavior of children during the sessions and in their reactions to the Visualizer, but indicated that the children were motivated to increase their vocalizations. They were encouraged by their successful matchings of the model patterns and discouraged by their failures. Interest in the Visualizer and the teaching materials decreased after the first month or two.

Clinical analysis of the experimental groups articulatory proficiency for the specific phonemes included in the experimental program indicated some improvement in articulatory proficiency for all children. Consonants appeared to improve more than vowels. Improvements in consonants were most noticeable in the reduction of substitutions of [b] for [m] and [t] for [s], greater length and force of breath on unvoiced fricatives [f, s, ,], reduction of tendency to emit consonants, reduction of tendency to add "extra" phonemes, improvement of ability to produce the voiced fricatives [v, z] by encouraging the addition of voice to friction rather than the substitution of a vowel-like sound for the voiced fricatives. Improvements in vowel production were more noticeable for the back vowels [a, o, u] than for the front vowels [i, e], Observed changes in the articulation of the experimental consonants and vowels were not accompanied by improvements in the general intelligibility of words spoken by the children.

The articulatory errors of the "advanced speaker's" group tended to be related to the fricative and plosive consonants. Improvements in articulatory proficiency were readily noticeable to the research staff observers and tended to be accompanied by identifiable increases in the intelligibility of each child's speech.

The New Voice Visualizer

The Voice Visualizer has been redesigned to take advantage of modern solid-state circuits and to permit construction at a reasonable cost. Two units based on the new designs have been constructed by Aspen Products of 143 Prospect Street, Shrewsbury, Massachusetts. Figures 7 and 8 show views of the Visualizer. The basic principle of the Visualizer remains as it was first described (8,9), namely, the use of a pair of wide-band 90° phase-splitting networks to obtain a set of voltages for moving a cathode-ray-tube (CRT) spot such that a sine wave in the audio frequency range produces a circle on the screen. A second feature of the Visualizer which was retained from a previous Visualizer built at MIT is automatic size control for the pattern on the CRT screen, so that its size varies only slightly as the input speech volume varies over a 25-db range.

The design of the new Visualizer leans heavily on the inexpensive epoxy-encapsulate NPN transistor with B in range 100 to 300. The type used was a Motorola type easily obtainable at the time of the design. Any other NPN transistor with the rated B at 1-5 ma 300 mw dissipation rating could be used interchangeably with the one selected here.

A new feature was the addition of an earphone output circuit. This circuit has sufficient power to drive a pair of high-fidelity earphones to about 120 db average sound pressure level in each ear, and a pair of 3 kc bandwidth earphones to about 135 to 140 db sound pressure level. (These pressure levels are on the basis of earphone manufacturers specifications. They are roughly confirmed by listening. No coupler measurements were made.)

The addition of the earphones as an audio clue must be viewed as a mixed blessing from the point of view of instrument engineering. In practice, on some heads there is substantial acoustic leakage from the earphones to the microphone, resulting in a tendency to "sing" when the voice volume is low. To partially offset this tendency to "sing" it was necessary to reduce the range of speech volume over which the pattern size remains nearly unchanged. This reduction in range has led to the dropping of some final weak sounds (such as in "laugh") from easy visibility on the screen in dynamic speech. It is to be hoped that at some future time a successful experiment can be carried out with earphones that fit snugly into the outer ear, rather than ones which fit loosely over it.

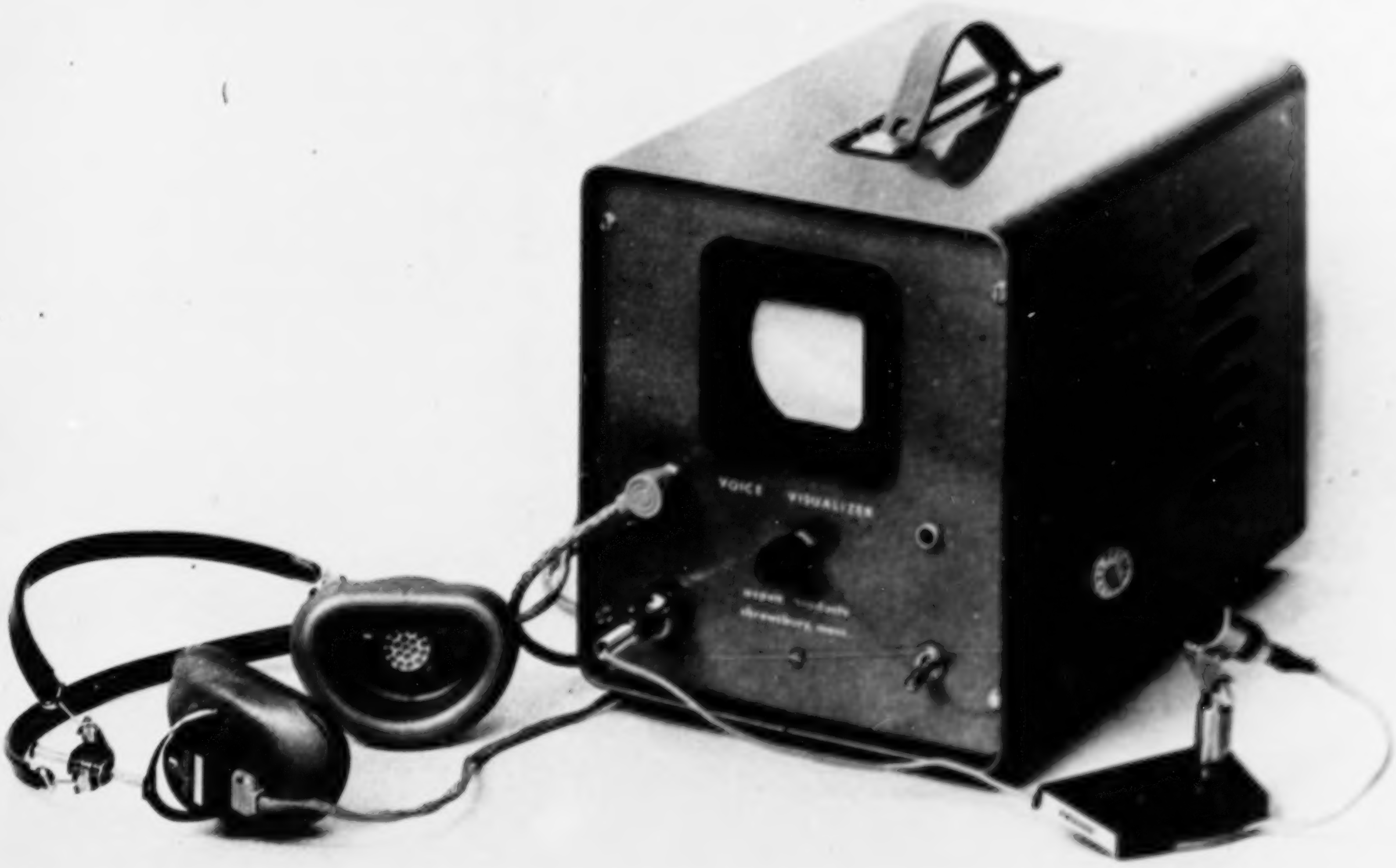

VOICE VISUALIZER

Figure 7. The Voice Visualizer with microphone and headset.

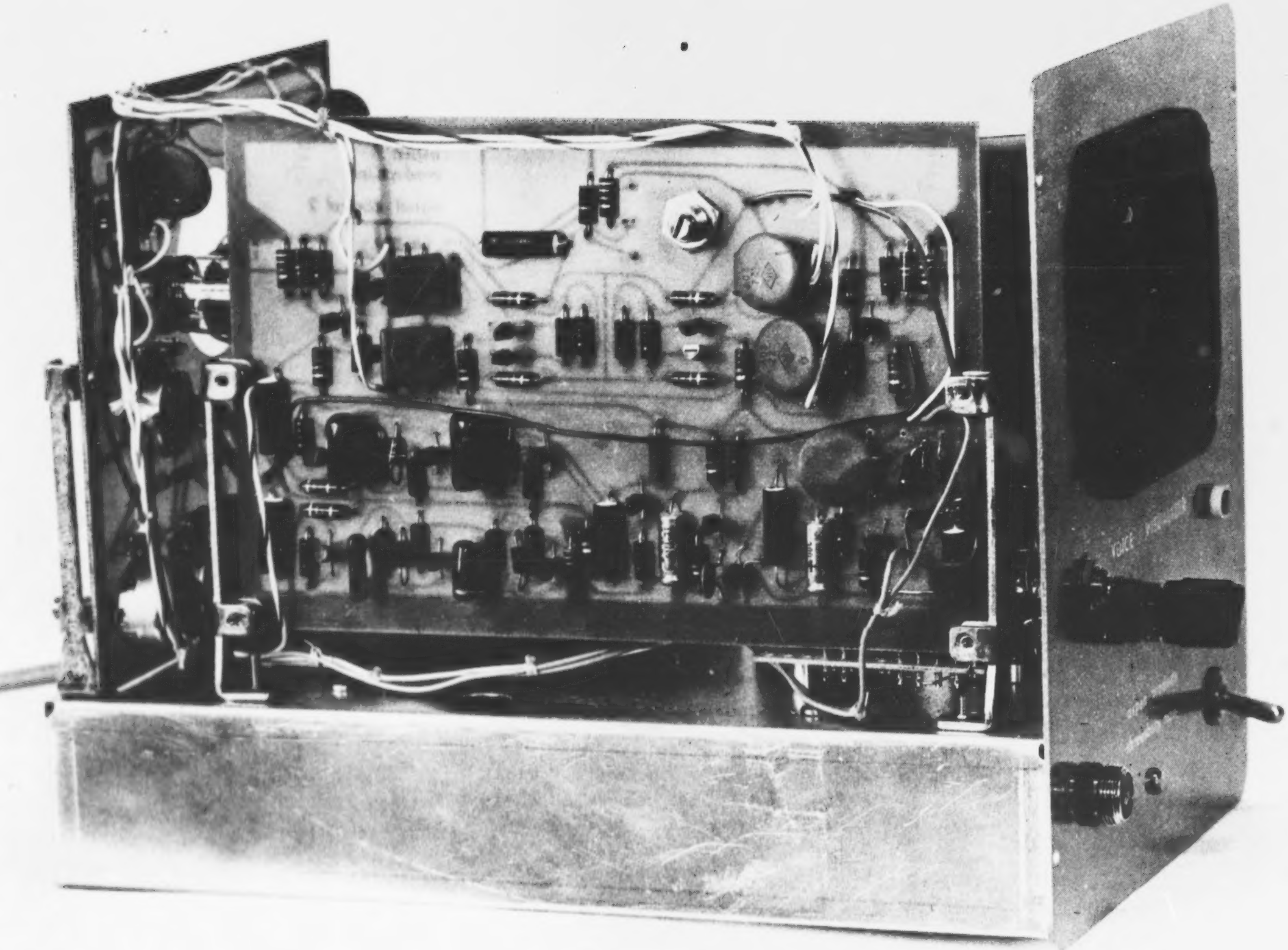

VOICE VISUALIZER

Figure 8. Interior view of The Voice Visualizer

Block Diagram. The basic block diagram of the Voice Visualizer is shown in Figure 9.

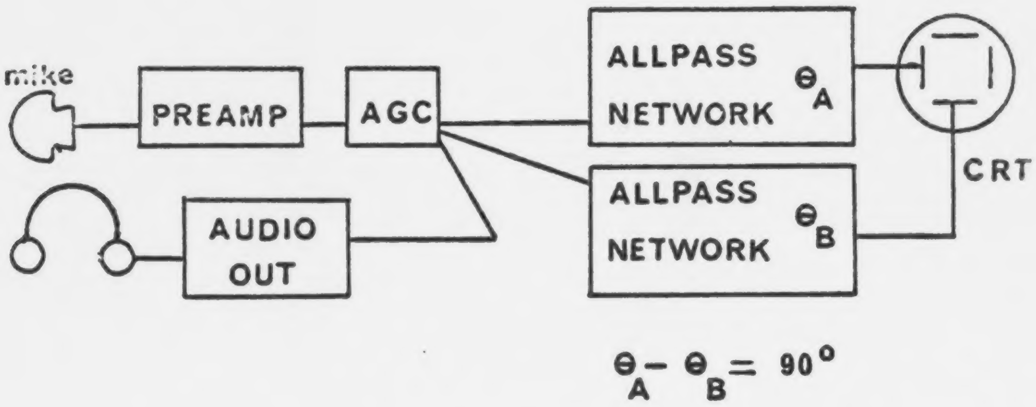

mike
PREAMP
AGC
AUDIO OUT
ALLPASS NETWORK Θ_A
ALLPASS NETWORK Θ_B
CRT
$\Theta_A - \Theta_B = 90^\circ$

Figure 9. Block Diagram of Visualizer

The individual circuits for the blocks were developed by Robert Lerner. The actual construction of two models of the Voice Visualizer was carried out by Aspen Products of 143 Prospect Street in Shrewsbury, Mass. under his direct supervision. The Voice Visualizer contains three basic sections. In the first group are audio frequency amplifiers to bring the microphone signal up to a sufficient level to operate the signal processing circuits without the need for elaborate shielding. In the second group are the circuits to operate a 3 inch cathode ray oscilloscope, which is an integral part of the equipment. In the third group are an automatic gain control circuit to hold the size of the pattern roughly constant over a range of variation of voice volume, and the 90° phase-splitting networks which in effect generate the patterns.

The circuits for the Preamplifier, Audio Output Amplifier, and Cathode Ray Tube (CRT) deflection are routine, so that these will be mentioned only briefly later. The two key operations in the Visualizer are the Automatic Gain Control (AGC) and the Phase Splitters. Of these, the fundamental pattern formation is done in the phase splitters as follows.

90° Allpass Phase Splitting Networks. An "allpass" network is one that transmits all frequencies with the same uniform gain, but introduces a frequency - dependent phase shift . What is desired is a constant phase shift of 90°, so as to obtain two voltages 90° out of phase with which to deflect the CRT spot. Thus, a sine wave input of any frequency would give a circular locus on the CRT. The shape of this circle would be clearly independent of frequency and its diameter would be proportional to the strength of the input sine wave.

It is not possible to produce a single all-pass network whose phase shift is even approximately 90°; but it is possible to design a pair of all-pass networks, A and B, having phase shifts ${}_A$ and ${}_B$ such that the difference between ${}_A$ and ${}_B$ is as close to 90° as desired over as broad a bandwidth as desired. In the Visualizer, 4 basic all-pass building blocks are used to synthesize a phase difference ${}_A$ - ${}_B$ which is within ± 6° of 90° from 90 cps to 5500 cps.

The design of 90° phase-splitters is discussed in the engineering literature (2, 10) and will not be reviewed here. The basic all-pass circuit used in the present Visualizers is that shown in Figure 10.

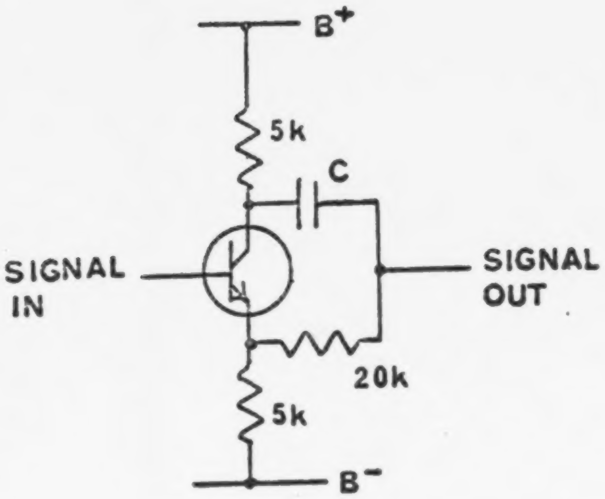


Figure 10. Allpass Network Section

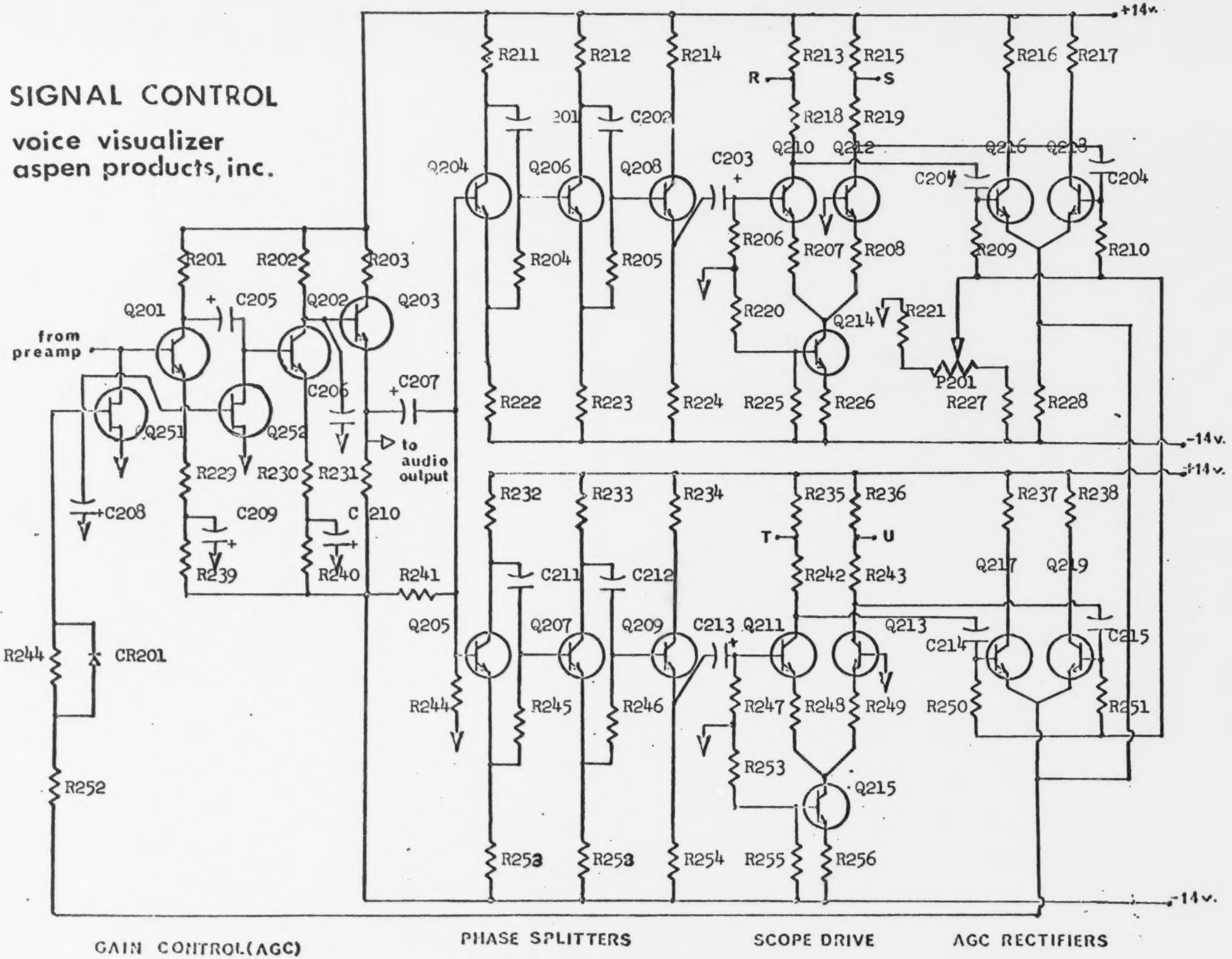
Here, the input and output signal are at the same level. The resistors are chosen at 1% for stability. The capacitor C is chosen to meet the network design criteria. The central portion of the "signal Control" circuit diagram, Figure 11, constitutes the phase splitter. There, the circuits surrounding Q 204 - Q 207 make up the phase-splitter. It is driven by the emitter-follower Q 203. The two-phase-splitter outputs pass through emitter-follower buffer amplifiers Q 208 and Q 209 to a pair of low-gain amplifiers Q 210-Q 212-Q 214 and Q 211-Q 213-Q 215, which provide push-pull drive for the oscilloscope section of the Visualizer.

ACC Circuit. The ACC is accomplished through two amplifier stages Q 201 and Q 202 in the signal control diagram, and two variable-loss field effect transistors (FET) operated as variable resistors. The amplifiers have a normal gain of 60 db. Each FET acts as a gain-decreasing shunt on the previous amplifier stage (in the case of Q 251 this preceding stage is in the preamp). With the FET's biased all the way "off" the full 60-db gain would be operative. With the FET's all the way "on" about 80 db of attenuation is inserted for a net loss of 20 db.

In practice, the FET's are never turned all the way "off." Some turn-on bias is supplied by the 25 k potentiometer P 201 which partly controls the size of the pattern on the CRT screen and partly the weak signal sensitivity of the AGC. If the weak signal sensitivity is turned up too high, the AGC will "motorboat," giving a pattern which periodically seems to explode. P 201 is an internal adjustment which should be made only by a qualified electronic technician who fully understands the shock hazards of the Visualizer circuitry.

Not shown in the diagram is a ten megohm resistor which is added between the base of Q 251 and ground to further reduce weak signal sensitivity against the hazard of "signing" when an audio output amplifier is used.

The signal to control the attenuator is obtained from the output itself, through transistors Q 216-Q 219 connected as signal rectifiers. This control signal is applied to the FET's through a syllabic attack-and-release time constant network which includes diode CR 201 and capacitor C 201. Without the 10 megohm singing supressor, the AGC can be set to give a 2 to 1 variation in the diameter of the CRT pattern for a 30-db variation in input volume.


SIGNAL CONTROL
voice visualizer
aspen products, inc.
from preamp
Q201
Q202
Q203
Q204
Q205
Q206
Q207
Q208
Q209
Q210
Q211
Q212
Q213
Q214
Q215
Q216
Q217
Q218
Q219
Q251
Q252
R201
R202
R203
R204
R205
R206
R207
R208
R209
R210
R211
R212
R213
R214
R215
R216
R217
R218
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R220
R221
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R227
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R248
R249
R250
R251
R252
R253
R254
R255
R256
P201
C201
C202
C203
C204
C205
C206
C207
C208
C209
C210
C211
C212
C213
C214
C215
CR201
R
S
T
U
to audio output
+14v.
-14v.
GAIN CONTROL(AGC)
PHASE SPLITTERS
SCOPE DRIVE
AGC RECTIFIERS

Figure 11. Signal control circuits

TABLE VI.

Parts List - Signal control Circuits

R201	10k	R221	1.0k	R241	22k
R202	10k	R222	5.0k 1%	R242	1500 5%
R203	220	R223	5.0k 1%	R243	1500 5%
R204	20k 1%	R224	4.7k	R244	30k
R205	20k 1%	R225	47k	R245	20k 1%
R206	22k	R226	470	R246	20k 1%
R207	510 5%	R227	47k	R247	22k
R208	510 5%	R228	22k	R248	510 5%
R209	22k	R229	470	R249	510 5%
R210	22k	R230	240	R250	22k
R211	5.0k 1%	R231	7.5k	R251	22k
R212	5.0k 1%	R232	5.0k 1%	R252	100k
R213	820 5%	R233	5.0k 1%	R253	5.0k 1%
R214	220	R234	220	R254	4.7k
R215	820 5%	R235	560 5%	R255	47k
R216	220	R236	560 5%	R256	470
R217	220	R237	220	R257	
R218	1200 5%	R238	220	R258	5.0k 1%
R219	1200 5%	R239	22k		
R220	15K	R240	22k		

C201	.075 μ mylar	C211	.014μ mylar
C202	.0035μ mylar	C212	620 pf mica
C203	10μ 25 wvdc	C213	10μ 25 wvdc
C204	0.2μ	C214	0.2μ
C205	10μ 25 wvdc	C215	0.2μ
C206	.001μ		
C207	10μ 25 wvdc		
C208	0.2μ ceramic		
C209	20μ 10 wvdc		
C210	20μ 10 wvdc		

Q201 through Q219 2N4124

Q251 TIS34 (Texas Instruments)
Q252 MPF 104 (Motorola)

CR201 1N4153

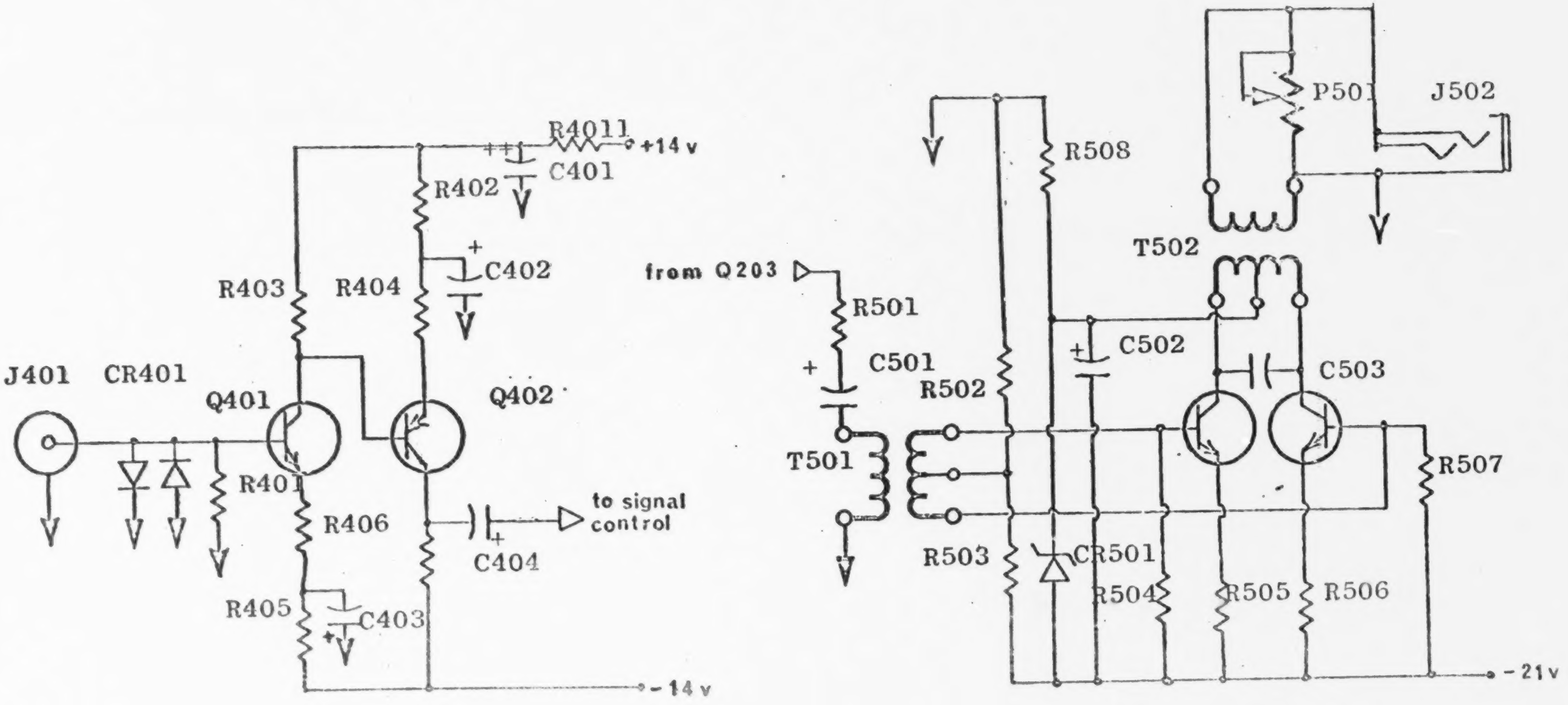
Resistors ½ or ¼ watt 10% tolerance unless otherwise noted. Values in ohms. k = kilohms, μ = microfarads, pf = picofarads.

Audio Input and Output Circuits. (Figure 12). The design of the preamp permits accommodation to a variety of microphone impedance levels, by proper selection of Q 401 and R 406. Once chosen, however, the optimum level for the microphone can be changed only by changing these resistors (a soldering job). The two Visualizers supplied are wired for 50,000 chms impedance level for the microphone input.

The audio power amplifier is capable of 200 mv continuous output, but normally operates at about 20 mw to avoid peak-clipping distribution of the speech. It is a class B amplifier with the transistors Q 501 and Q 502 operating with quiescent bias currents of about 5 ma. Power from this amplifier is taken from the unregulated negative power supply. The Zener diode CR 501 does not regulate; it prevents the voltage swings at the collectors of Q 501 and Q 502 from exceeding ratings. Q 501 and Q 502 constitute a class B amplifier biased with quiescent currents of about 5 ma. If substitute transistors are used, they should have a current gain of at least 50 and should be rated for at least 40 volts collector-base breakdown at cutoff.

The volume control of P 501 can be either a 25 ohm potentiometer in the position shown, or a 5 K potentiometer bridged between the transistor collectors. In either case, a logarithmic taper should be used.

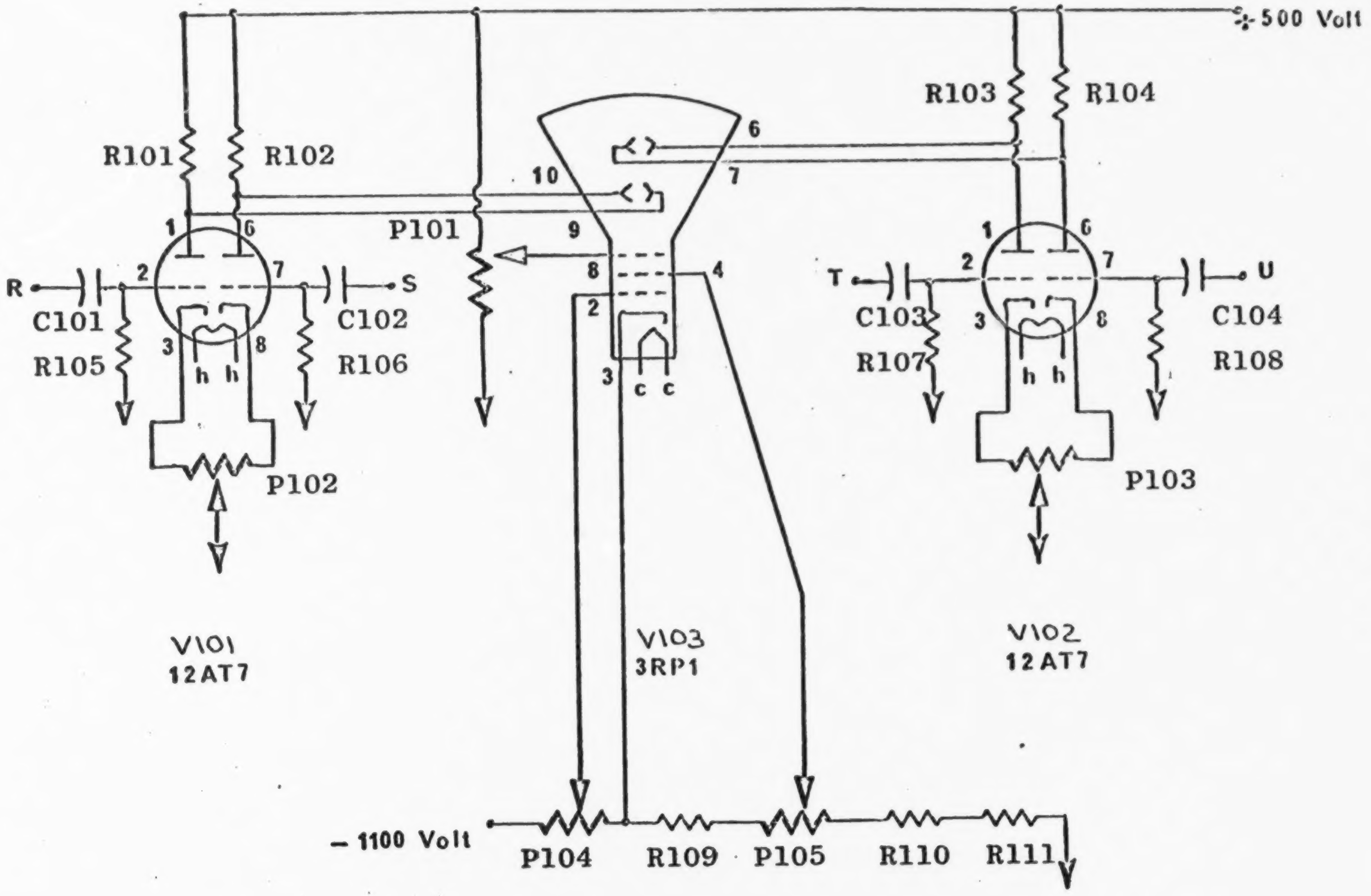
Scope Drive. The Oscilloscope section of the Visualizer is shown in the diagram of Figure 13. The deflection plates of the CRT are driven directly from the plate circuits of the push-pull amplifiers V 101 and V 102. The CRT ultor is brought to the same average potential on the deflection plates by means of the astigmatism control P 101. Centering is accomplished by varying the centertap on the cathode potentiometers P 102 and P 103. There should be no need to adjust any of the oscilloscope controls in the normal operation of the Visualizer. These adjustments are therefore internal and should be made only by a qualified technician. The oscilloscope circuits constitute the rear panel of the Visualizer internally. Both the oscilloscope and the power supply which serves it have voltages at +500 V and -1100 V, which are potentially lethal. Both of these supplies should be discharged to ground before servicing; the +500 V supply has an especially long natural time constant.


J401
CR401
Q401
R403
R404
R401
R406
R405
C403
R402
R4011
+14 v
C401
C402
Q402
C404
to signal control
-14 v
from Q203
R501
C501
T501
R502
R503
R508
C502
CR501
R504
R505
R506
T502
C503
P501
J502
R507
-21v

PREAMP

200 mw POWER AMP

Figure 12. Audio input and output circuits.



500 Volt
R101
R102
R103
R104
10
9
8
2
3
c c
6
7
4
1
6
2
7
3
8
h h
R
C101
R105
S
C102
R106
P101
P102
V101
12AT7
V103
3RP1
T
C103
R107
U
C104
R108
P103
V102
12AT7
– 1100 Volt
P104
R109
P105
R110
R111

Figure 13. Scope drive circuits

TABLE VII.

Parts List - Audio Amplifiers

R401	47k	R501	750
R402	10k	R502	22k
R403	10k	R503	1.2k
R404	680	R504	12k
R405	33k	R505	51 5%
R406	1.0k	R506	51 5%
		R507	12k
		R508	220
C401	10μ 25wvdc	C501	2μ 35wvdc
C402	10μ 25wvdc	C502	15μ 25wvdc
C403	25μ 10wvdc	C503	0.02μ
C404	10μ 25wvdc		
T501	UTC DOT37		
T502	UTC DOT34		
P501	25 or 10k (depending on location) log taper		
CR501	18 volt Zener lwatt		

TABLE VIII.

Parts List - Scope Drive

R101 to R104	82k 5% 2 watt
R105 to R108	100k
R109	1.5 meg.
R110	3.0 meg.
R111	3.0 meg.
C101 to C104	0.2μ ceramic
P101	500k 2 watt
P102	5k 1/2 watt
P103	5k 1/2 watt
P104	500k 2 watt
P105	2.5 meg. 1/2 watt

Power Supply. The power supply wiring of the Visualizer is shown in Figure 14. The Visualizer is supplied with a standard grounding type of 3-wire 115 V. a.c. line cord. It is fused for 1 ampere and draws approximately 50 watts of power from the line. It is transformer-coupled internally for safety, and so will only operate on attenuating current. The 500 and 1100 volt supplies are unregulated, as is the -21 volts. The +14 and -14 volt supplies are potentially lethal and are active long after the instrument has been shut off. Repairs and adjustments should be attempted only by qualified technical personnel who fully understand the operation of the Visualizer circuits and the hazards of working on live circuits.

Possible Adaptations. Depending upon the situation and the intended use of the Visualizer, certain adaptations may be desired.

1. The use of driver units and earmolds instead of headsets would reduce sound leakage and permit higher amplifications for auditory feedback.

2. A boom microphone attached to a headset would maintain a constant distance from the microphone and eliminate necessity of moving the microphone.

3. For extensive use in individual teacher-pupil situations, a separate microphone for the teacher and child could be used in inclusion of a mixer circuit into the audio input circuit.

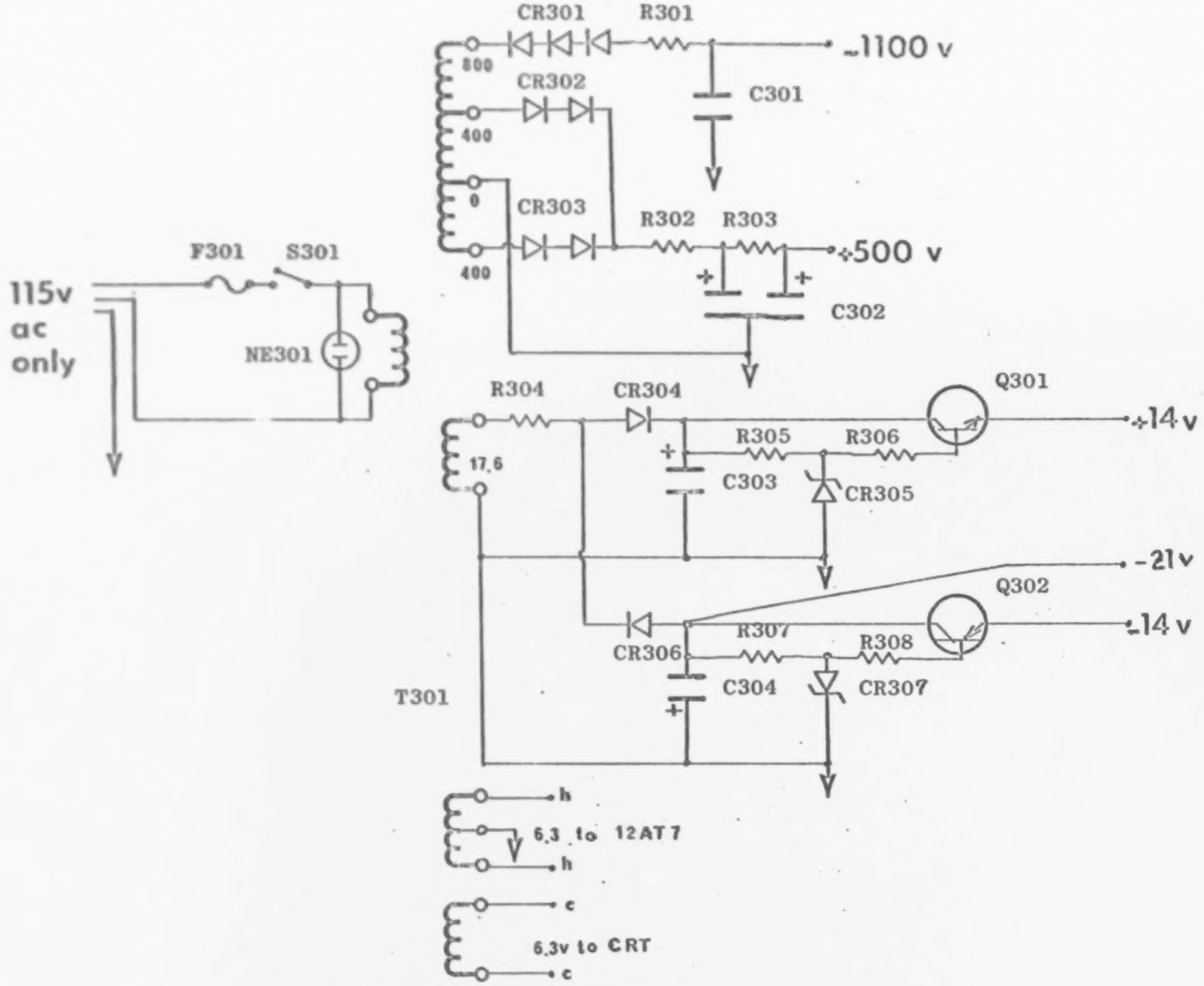

CR301
R301
-1100 v
800
CR302
C301
400
0
CR303
R302
R303
+500 v
400
F301
S301
115v
ac
only
NE301
C302
R304
CR304
Q301
+14 v
17.6
R305
R306
C303
CR305
-21v
Q302
-14 v
R307
R308
CR306
C304
CR307
T301
h
6.3 to 12AT7
h
c
6.3v to CRT
c

Figure 14. Power Supply Circuit.

TABLE IX.

Parts List - Power Supply

R301	10k
R302	1.0k
R303	1.0k
R304	20
R305	1.0k
R306	220
R307	1.0k
R308	220

CR301	Sarkes F8 (3)
CR302	Sarkes F8 (2)
CR303	Sarkes F8 (2)
CR304	Sarkes F1
CR305	15 volt 5% Zener
CR306	Sarkes F1
CR307	15 volt 5% Zener

C301	0.25μ 1500 wv oil
C302	20 - 20 @ 500wvdc electrolytic
C303	500μ 50 wvdc
C304	500μ 50 wvdc

F301 1 amp 3 AG fuse

S301 SPST line switch

NE301 Leecraft 36N2311-6

Line Cord Belden 17327S
T301 Triad R45C

Manual of Materials and Procedures for the Voice Visualizer

The Voice Visualizer is a supplemental aid for the development and correction of vowel and consonant articulation in the speech of the deaf. It provides the child with instantaneous visual information about the accuracy of his articulation of certain vowels and consonants. Its use by teachers and clinicians is recommended in combination with, and supplemental to, the variety of multi-sensory approaches which are used according to a child's individual needs. A research and development project has demonstrated that the Visualizer is most effective:

1. In motivating deaf children to increase the number and variety of their vocalizations by producing changing patterns on the Visualizer screen.

2. In reinforcing the deaf child's correct articulations of initial and final consonants, and vowels, in stressed monosyllabic words, by providing the child with instantaneous visual feedback for self-monitoring.

The Visualizer may be used in either group or individual sessions. It may also be used by children for self-monitoring during short self-practice sessions. In addition to the visual feedback, auditory feedback through headphones is available.

The Voice Visualizer provides an instantaneous oscilloscopic display of patterns representative of acoustic characteristics of vowels and consonants. Since patterns of some acoustically similar speech sounds cannot be discriminated visually, the Visualizer program was developed for five vowels and seven consonants whose patterns are distinctive. While patterns vary slightly from speaker to speaker, the photographs on the following pages can be matched by either teachers or children. When teachers or children speaking within their normal pitch range match a model pattern, the acoustic characteristics of the sound will be easily recognizable as the desired speech sound. (It should be noted, however, that if a child vocalizes outside of his normal pitch range, inappropriate patterns may be produced.)

It is important to realize that the Voice Visualizer provides a visual display of certain acoustic features of vowels and consonants. A deaf child must somehow convert these visual clues into internal kinesthetic clues concerning speech musculature movements. How a child does this is not known, but research data and clinical experience have indicated that children can use the visual feed back of the Visualizer in conjunction with other visual (mirror), kinesthetic and auditory feedback, as well as feedback from his teacher to assist him in articulating vowels and consonants more accurately.

Introductory Procedures

The Voice Visualizer is simple to operate. It has only two controls - an OFF-ON power switch, and a volume control for the headphones. It is a lightweight unit. If care is used in carrying it from place to place, it can be moved, and should not require servicing, except for annual checks by a technician.

Use of the Visualizer before a large mirror is desirable so that visual communication between teacher and child can occur through the mirror, encouraging the child to watch the Visualizer screen at all times and eliminating the loss of time involved in constantly shifting attention from front to side.

Some preliminary teaching of visual pattern matching should be undertaken. Each child should be asked to match geometric patterns, to engage in rapid identification of one pattern from a group of patterns, and to match photographs of Visualizer patterns. The teacher should then turn the Visualizer ON and show him how she can use her voice and speech to produce different patterns on the screen. She should also place four photographs of distinctly different vowel and consonant patterns in front of the machine and ask the child to point to the photograph which matches the pattern she produces on the screen.

A teacher should experiment with the Visualizer before working with children so that she can match the model patterns of the photographs. She may have to vary her own articulation of a vowel in order to match the model pattern. This procedure is necessary unless the teacher wishes to make photographs of her own patterns to use as models for the children. Consonant patterns can be matched more readily as they are less susceptible to differences among speakers.

Following these visual pattern-matching activities, which the child should be able to complete successfully, the teacher should hand the microphone to the child and encourage him to experiment with making different patterns himself. However, at this time the child should not be expected to match any one pattern exactly in his own speech, although he might realize that he can.

The procedures described in the illustrative approaches in this manual are designed for those children who have adequate vocal intensity and can sustain vocalization for the duration of a monosyllabic word. Adaptations to children with less ability are presented at the end of the manual.

It is recommended that sounds be taught in contrasting pairs, such that one sound is a sound which the child articulates well. Thus, the child will experience success in matching one pattern while also attempting to improve the articulation of another. In order to encourage normal speech rhythms in word units and also simplify the visual perceptual task involved in self-monitoring, it is recommended that monosyllabic words be used in the initial sessions with each contrasting pair of sounds. In addition, it is recommended that consonants and vowels be taught in different lessons, since the monitoring task for consonants involves perception of a pattern occurring at the beginning or end of a word, while the monitoring task for the vowel involves perception of a pattern occurring in the middle of the monosyllabic word.

Materials for a session include the photographs of the Visualizer patterns of the two contrasting sounds. (The photographs on the following pages should be cut out and mounted on cardboard). The photographs are placed on opposite sides of the Visualizer screen. The words for each sound should be printed at the top of 5" x 7" flash cards on which pictures representing the word can be glued. Magazines and mail-order catalogues are excellent sources of pictures. This manual contains the word lists most useful in teaching consonant and vowel articulation with the Visualizer. Some of the words listed cannot be pictured easily, but printed forms alone may be used if the child is familiar with the word. An attempt has been made to select word pairs which are phonetically similar except for the contrasting sounds. The arrangement of the photographs and flash cards on the Visualizer rack is shown in Figure 18. The Visualizer should be placed on a table whose height permits the Visualizer screen to be at a child's eye level when he is seated before it.

It is recommended that sessions with the Visualizer for each child begin with consonants. There are greater possibilities for early success with certain consonants because of the lip-reading and kinesthetic clues available to the child coincident with the Visualizer feed back information. In all sessions, the teacher should analyze the child's articulatory attempts and provide him with as much visual, kinesthetic, tactile and auditory information as she can in order to help him articulate accurately. The Voice Visualizer can reinforce a child's articulatory behavior but it cannot give him much information about what he should do differently. It tells him immediately whether he is right or wrong. Its greatest usefulness is in the instantaneous reinforcement of his successful attempts to articulate accurately. However, with increasing practice and experience, teacher and child can use certain features of the visualizer patterns to indicate what a child should try to do to increase articulatory proficiency.

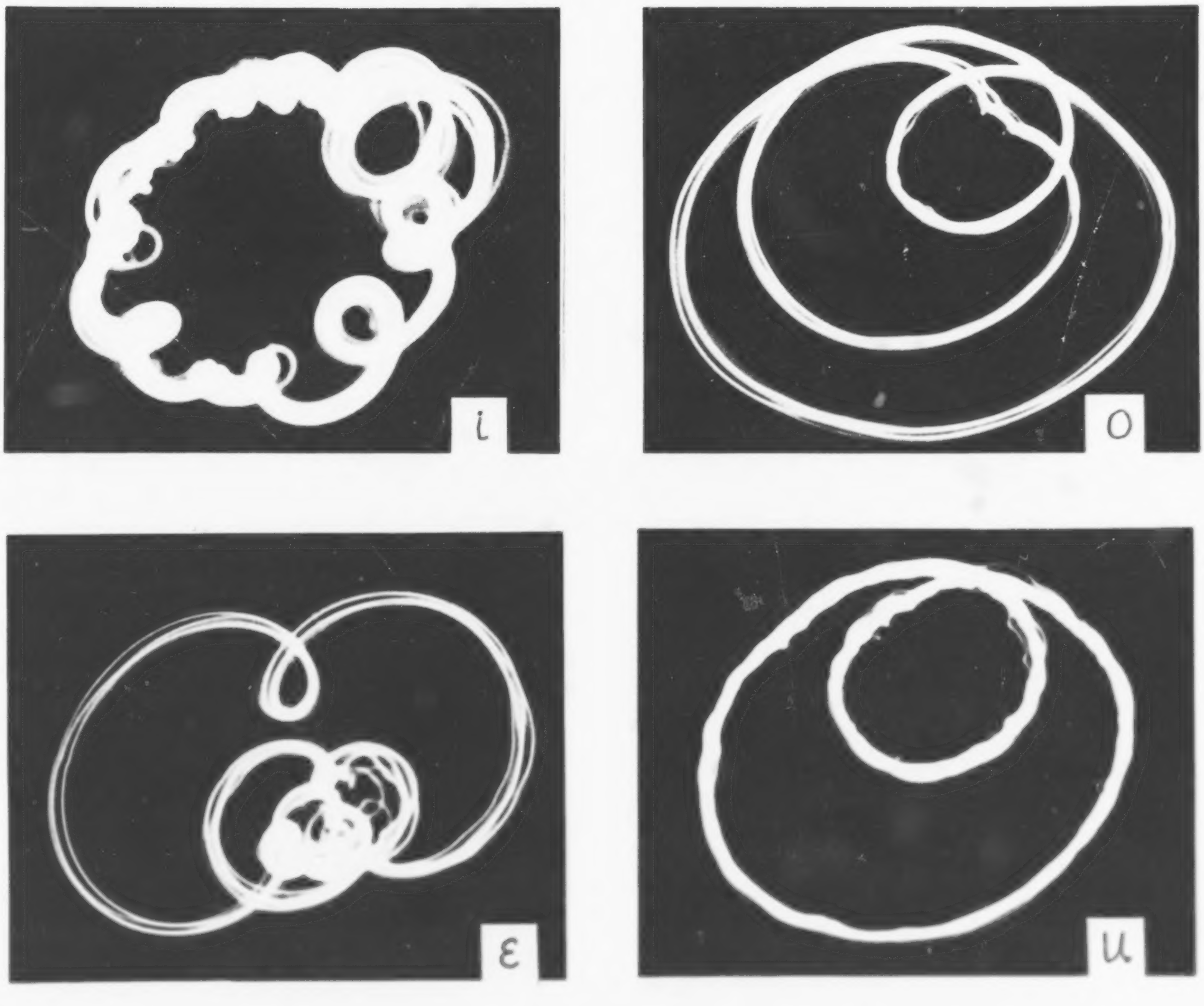


Figure 15. Patterns of [i, ε, o, u]

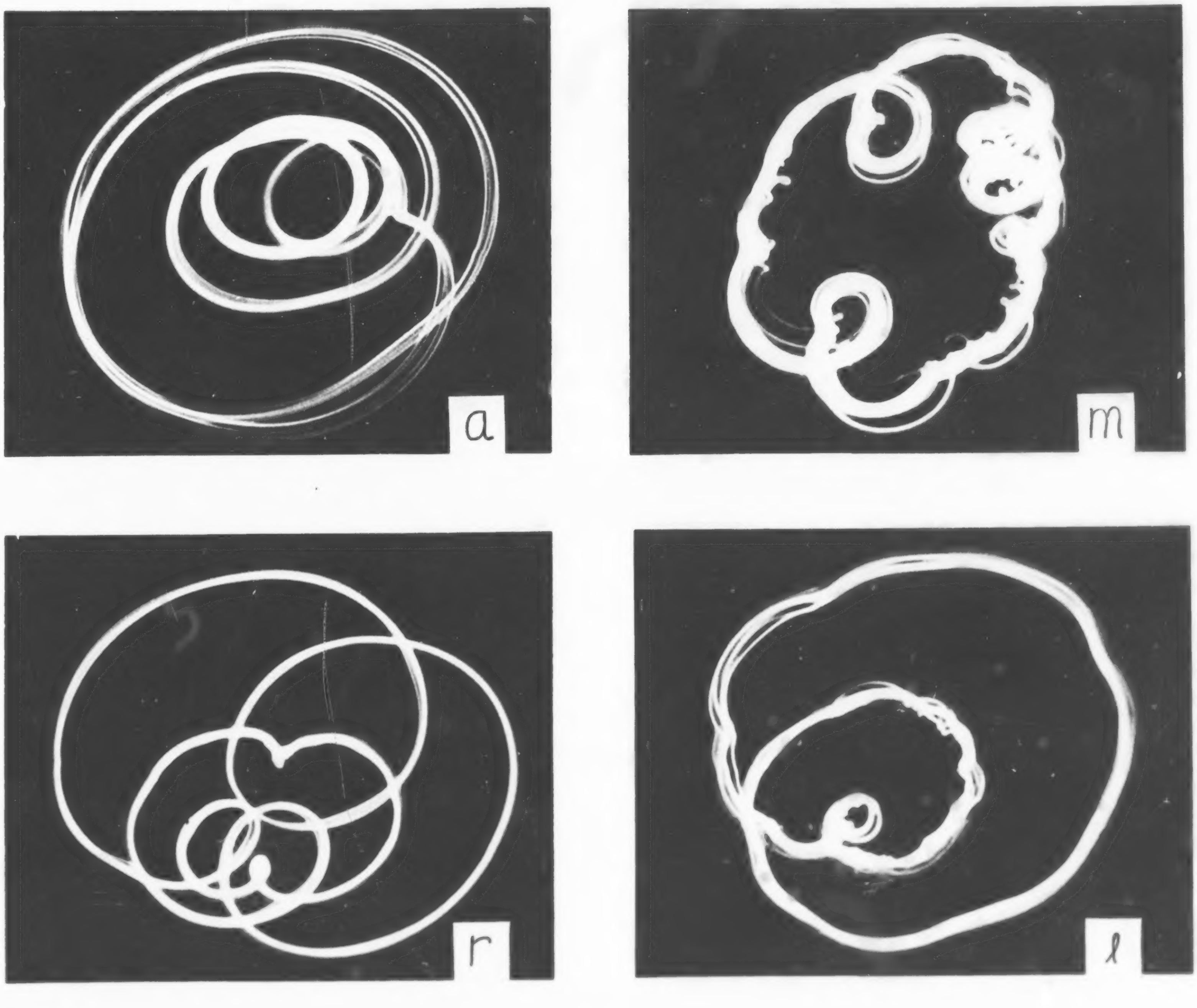


Figure 16. Patterns of [a, m, r, l]

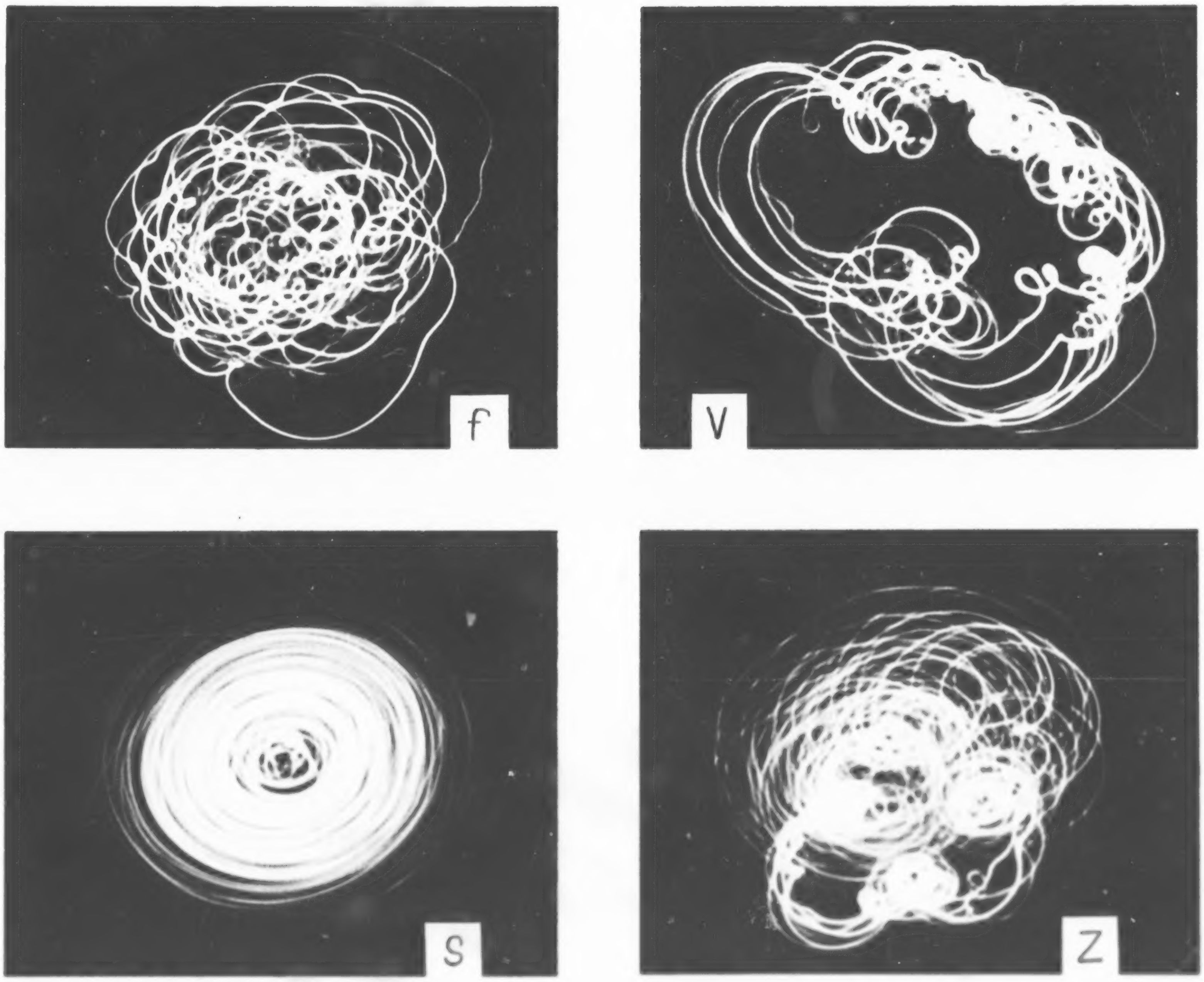


Figure 17. Patterns of [f, v, s, z]

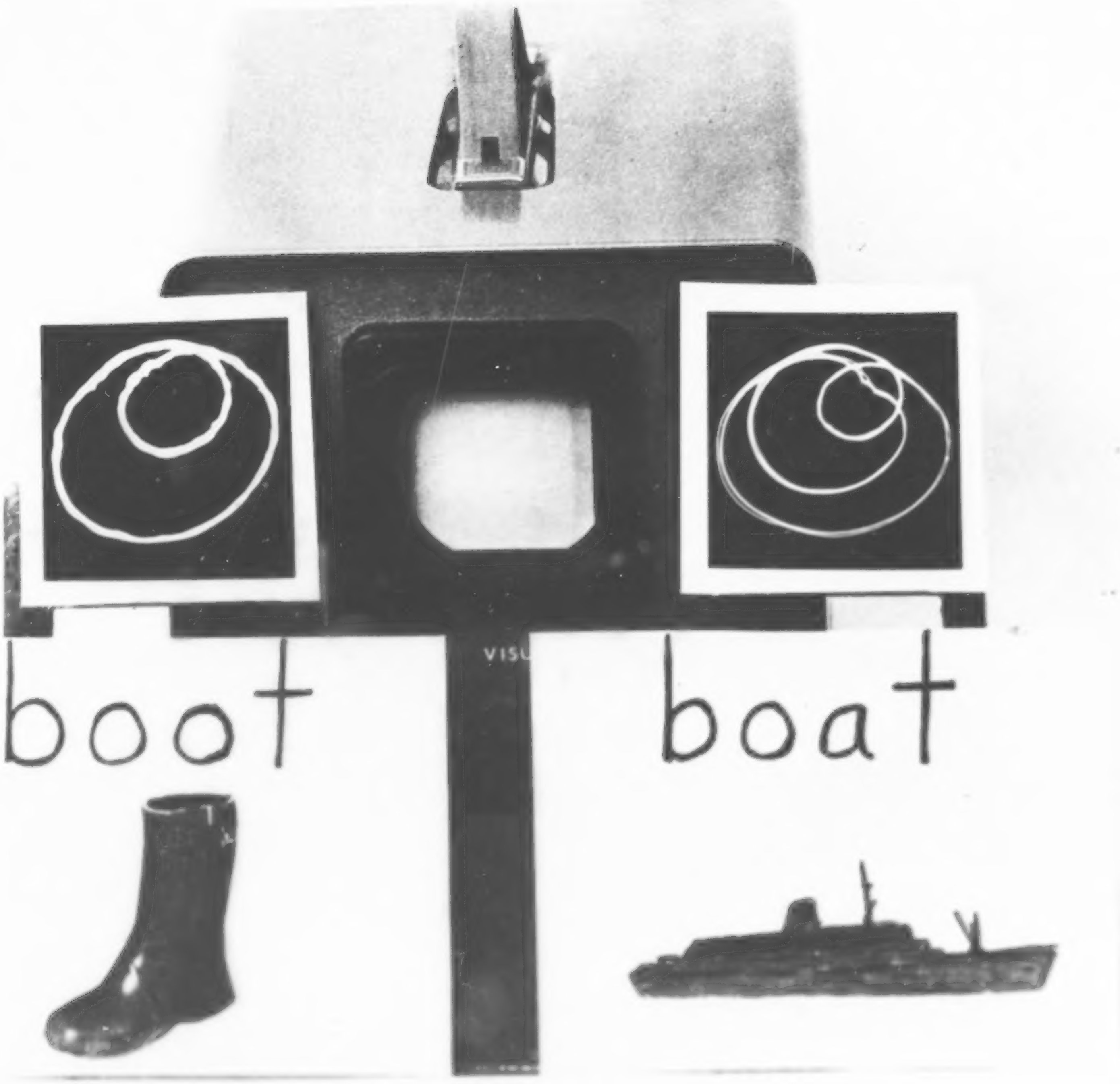

boot
VISU
boat

Figure 18. Arrangement of teaching materials on equipment.

Illustrative Approach for Consonants

The procedures described here are illustrative only although they are based on experience with an experimental program. These illustrative approaches are designed to help teachers become familiar with the essential features of a program to be used with the Visualizer. As teachers and children become more familiar with the Visualizer, numerous ideas for variations in approach will occur to both, and are to be encouraged.

Objectives:

1. To develop visual discrimination of the Visualizer patterns of [p] and [f] by noticing differences in the duration of the two sounds in spoken words.

2. To develop visual discrimination of the location of the desired Visualizer pattern at the beginning and end of words through utilization of the pattern for [f].

3. To develop visual discrimination of voiced and breath sounds through use of patterns of [m] and [f].

4. To develop a child's ability to articulate [p] and [f] accurately in initial and final positions of words through use of contrasts between [p] and [f].

5. To develop a child's abilty to produce voiced and breath sounds through contrasts between [m] and [f].

Procedures:

1. Visual discrimination of duration of patterns: Place the photograph of the [f] pattern at the right of the Visualizer screen and a card of the symbol [p] at the left of the screen, on the rack provided. Illustrate the rapid flashing pattern as you articulate [p-p-p]. Demonstrate the pattern of a slightly prolonged [f]. Randomly articulate [p] or [f] and ask the child to point to the photograph of the sound you produce. Cover your lips so he cannot lipread and must watch the Visualizer screen.

2. Visual discrimination of [p] and [f] in words: Prepare flash cards for each of the following [p] and [f] words:

put - foot
pat - fat
pan - fan
pool - food
pie - five

pork - fork
pull - full
peas - feet
purr - fur
pound - found

Arrange the cards so that phonetically similar [p] and [f] words will be beside each other as you progress through the pairs. Place the cards on the Visualizer rack below the corresponding Visualizer photograph of [f] or the symbol [p]. Instruct the child to watch for the [f] and [p] patterns as you say the series of word pairs. Let the child flip the flash cards to a face down position as you go through the series. Repeat the series, saying only one word of the pair and ask the child to watch the Visualizer pattern and indicate which word you spoke. Shift randomly between [p] and [f] words.

3. Child's self-monitoring of [p] and [f] in initial position of words: Replace the paired word cards on the rack. Let the child practice producing [p] and [f] as single sounds and observe his own pattern-matching attempts. Help him to articulate the sounds accurately by any multi-sensory or explanatory approaches you can devise. Then, ask the child to say the word pairs and to monitor his articulatory attempts on the Visualizer screen. Help him when he needs help, but encourage him to use the Visualizer to determine whether he has spoken the words with accurate articulation of [p] or [f]. Encourage rapid articulation of [p] but slightly prolonged articulation of [f]. Encourage normal duration of the entire word. Avoid separation of the phonemes. Normal duration is possible since the child is prolonging slightly and monitoring only the beginning of the word.

4. Visual discrimination between initial and final positions: Place photographs of the [f] pattern on both sides of the Visualizer screen. Place flash cards of the following words below:

far - arf
feet - leaf
five - knife
fat - laugh
food - roof
fly - life

Instruct the child to note whether the pattern occurs at the beginning or end as you say the words. Then, ask him to point to the left or right photograph as you randomly shift between initial and final position words.

5. Self-monitoring practice with final position [p] and [f]. Use the procedure of step 3 and the following word pairs:

cap - calf
puff - pup
lap - laugh
cup - cuff
cheap- chief
up - muff
wipe - wife

6. Child's self-monitoring practice with initial and final position of [f]. Use words of step 4 and procedures given in step 3.

7. Visual discrimination of [m] and [f]: Use the procedures described in step 2 with the following word pairs:

man - fan
more - for
meat - feet
mask- fast
my - fly

mine - fine
mouse-found
mew - few
mill - fill
mist - fist
mail - fail

mile - file
moon - phone
me - flea
mud - flood
mule - fuel

8. Self-monitoring of [m] and [f]. Use procedures of step 3. Emphasize the difference between the voiced [m] and the breath [f]. Prolong each one singly before using words. Use multi-sensory clues to help the child produce the [m] sound. Most children will do this readily but some may need instruction to increase vocal intensity or duration and to use sufficient nasal resonance.

9. Visual discrimination and self-monitoring of initial and final [m]. Use procedures of steps 4 and 5 with the following words:

milk - him
more - home

make - same
my - I'm

10. Self-monitoring of final [m] and [f] with the following word pairs:

room - roof
lamb - laugh
ham - half

beam - beef
same - safe
come - cuff

11. Review: Shuffle all the flash cards for initial and final positions of [p] [m] and [f]. Place photographs of [m] and [f] on opposite sides of the Visualiser screen. Let the child monitor his articulation as the flash cards present the three sounds randomly.

Additional review words:

fun
fine
pie
peach
rip
raft
fast
fat

pork
room
off
fish
comb
drum
fall
thumb

mailman
mother
family
father
fireman
farmer
famous
snowflakes

Materials for Other Consonant Pairs

The following materials present the word lists for other consonant pairs which can be used with the Voice Visualizer as a supplemental aid. The procedures just outlined can be used and adapted. The specific materials and the sequence for different consonant pairs will depend upon the individual child or classroom. It is suggested that the sequence always proceed from speech sounds the child can articulate accurately so that he can succeed with one of the contrast sounds while using the other to learn a new sound.

Contrasting [f] and [s]:

food - school
fan - sand
fat - sad
feet - seat
fun - sun
fin - sit
feet - see
fell - sell
fox - sox

knife - nice

fame - same
feed - seed
fine - sign
fur - sir
fold - sold
fit - sit
fed - said
foot - soot

laugh - glass

Additional review words:

Sue
raft
roof
saw

cats
mouse
off
fork
grass

phone
leaf
bus
sister

Initial and final [s]:

soup - goose
said - yes
say - cakes
sock - ox

sun - us
sat - cats
stop - tops
street- treats

Contrasting [f] and [v]:

The Voice Visualizer has been effective in helping children to produce the voiced fricatives. By using tactile-kinesthetic clues (feeling vocal cord vibration and breath simultaneously), children are usually able to produce the frictional component simultaneously with voicing for [v]. Instantaneous feed-back and self-monitoring

2

has been very useful in reinforcing these two necessary characteristics of voiced fricative sounds.

fine - vine
fur - verb
fan - van
face - vase

fat - vat
few - view
fail - veil
fowl - vowel
fest - vest

half - have
gift - give
leaf - leave
safe - save
fife - five

Additional review words:

phone
farm
glove
vase
voice
fish

knife
love
stove
chief
wave
fork
feet

off
roof
foot
valentine
very
T.V.

Contrasting [s] and [z]:

s-s-s - z-z-z

slip - zip
swim - zip
Sue - zoo
see - z
seal - zeal
sink - zinc

rice - rise
pace - pays
loose - lose
fuss - fuzz
first - furs
knees - niece
price - prize
fleece - fleas

geese - keys
house - cows
peace - peas
ice - eyes
boats - bows
ice - pies
bus - buzz

Additional review words:

is
soap
boys
school

nose
shoes
Miss
spoons

stars
stairs
sisters
glasses

Contrasting [s] and [t]:

Hearing impaired children often substitute [t] for [s] even when they have learned to articulate [s] accurately. The Visualizer pattern for [t] will be an abrupt "splash," not unlike the pattern for [p]. By using the symbol [t] in place of a photograph on the Visualizer rack, the following word pairs can be used to contrast [t] and [s].

s-s-s - t-t-t

soup - tooth
same - tame
sold - told
sell - tell
said - Ted
cent - tent
sub - tub
sick - tick

saw - talk
sock - tock
sun - tongue
soon - tune
sea - tea
Sue - two

bus - but
nice - night
rice - right
lice - light
piece - Pete
loose - loot
face - fat
yes - yet

Additional review words:

fat
mouse
fence

top
say
salt

dress
seat
sister

Contrasting [s] and omission of [s]:

wing - swing
pot - spot
key - ski
no - snow
net - nest
toe - stone
fat - fast
ink - sink
curl - skirt
Mac - mask

boat - boats
spot - spots
I - ice
how - house
sock - socks
light - lights
sick - six
nut - nuts
skate - skates

Contrasting [z] and [v]:

zoom - voom
Dave - days
have - has
eve - please

move - shoes
leave - peas
stove - nose
give - is

five - shoes
does - dove
close - clove
rose - rove

Additional review words:

zoo
vase
toys
boys

give
shoes
love
sleeve
vine

zip
glove
zebra
visit

Contrasting [b] and [m]:

Some deaf children substitute [b] for [m]. By placing the symbol [b] on one side of the Visualizer screen and the photograph of [m] on the other, the following contrasting pairs may assist children to use each sound accurately.

bee - me
bath - math
bow - mouth
beet - meet
build - milk
boot - moo
bun - month
buy - my
bunk - monk
batch - match
bake - make
bail - mail
bind - mind
bask - mask
bark - mark
cub - come
lab - lamb
bomb - Mom
sub - some

Additional review words:

boy
drum
broom
home
comb
bye-bye
box
gum

Contrasting [m] and [l]:

mow - low
man - land
map - laugh
mice - lie
me - leaf
make - lake
mouth - loud
moon - Lou
match - latch
mad - lad
mint - lint
moan - loan
mine - line
mink - link
mast - last
map - lap
moose - loose
mark - lark
mire - lyre
name - nail
them - shell
same - sail
farm - fall
dime - dial
steam - steal

Additional review words:

home
mill
lamp
meat
leg
hole
my
camel
lemon
lamb
school

Contrasting [m] and [r]:

moon - room
men - red
make - rake
rat - mat
mice - rice
my - ride
me - read
main - rain
man - ran
moon - room
mug - rug
mow - row
mail - rail
muff - rough
mole - roll
mound - round
mink - rink
him - hear
hem - hair
came - care

Additional review words:

milk
more
mouse
mask
red
rug
rose
road
mop
roll
mother
rocket

Contrasting [r] and [l]:

r-r-r - lu-lu-lu

read - leave
rock - lock
ram - lamb
rip - lip
rope - low
read - leaf
rake - lake
red - leg
raft - laugh
reef - leaf
reek - leak
rain - lane
ramp - lamp
wrong - long
rind - line
race - lace
rice - lice
right - light
girl - gr-r-r
for - fall
fur - full
car - call
fear - feel
pair - pail
roar - roll

Additional review words:

doll
more
lion
look
four
run
are
ball
school
round
left
little
rabbit

Review Phrases for Consonants

The following phrases contain the consonants which can be monitored on the Visualizer. However, monitoring of a consonant in a spoken phrase of normal rhythm and stress patterns is difficult. The phrases are included here for review and application to connected speech without any specific suggestion that the Visualizer be used for self-monitoring unless the teacher or child desires.

a small stove
my sister
give me some milk
five toys
sick in bed
five leaves
run to school
Batman and Robin
large and small
a small rug
a little girl
stop, look and listen
a doll house
shoes and socks
run around
visit a farm
yes, please
fork and spoon
knife and fork
ice cream and cake
four legs
m-m-m lemon pie
school days
right or left

soup and milk
a red rose
rake leaves
round or square
snow suit and gloves

Illustrative Approach for Vowels

Objectives:

1. To encourage children to experiment with voice usage to produce changes in vowel quality.

2. To develop visual discrimination of the Visualizer patterns of [a] and [i].

3. To increase a child's ability to vocalize the vowels [ɑ] and [i] accurately in monosyllabic words.

Procedures:

1. Experimentation with voice quality: Place the photographs of the [m] and [ɑ] patterns on the Visualizer rack. Demonstrate the pattern changes yourself. Then encourage the child to hum, matching the [m] pattern and to vocalize "ah," matching the [ɑ] pattern. Replace the [m] with the photograph of the [i] pattern and rapidly alternate vocalization between [ɑ] and [i], observing the pattern changes. Instruct the child to do the same. Do not expect perfect matching of the [i] pattern but rather encourage any changes from [ɑ]. With the [ɑ] and [i] photographs on the rack, encourage the child to babble rapidly [mɑ-mɑ-mɑ-mɑ] [bɑ-bɑ-bɑ-bɑ] [bi-bi-bi-bi] and [mi-mi-mi-mi], watching the pattern changes but noticing the repetition of the vowel pattern. Then, show the child how to say [mɑ-mi] and [bɑ-bi], with same babbling manner and then point out that the child has spoken "Mommy" and "Bobby". Maintain normal pitch rhythms during this vocalizing. Do not prolong the vowel sounds excessively.

2. Visual discrimination of [ɑ] and [i] patterns: With the photographs of the patterns on the rack and flashcards of the word pairs beneath, speak the contrasting words as if the words were in a stressed portion of a phrase. Thus, you will prolong the vowel slightly, making the pattern easily identifiable and yet maintaining the normal duration of a vowel in a stressed word. Instruct the child to note the pattern changes as you say each pair of words.

Note: The symbols on the photographs are those of the International Phonetic Alphabet. A teacher should paste on whatever system of symbols she normally uses - Northampton Chart, Initial Teaching Alphabet, Diacritics, etc.

ah - ee
art - eat
car - key

farm - feel
top - tea
far - feet
park - peas

ma - me
barn - bean
ha - he

Covering your lips so the child cannot lipread, instruct the child to watch the Visualizer screen and then point to the word you say. Speak only one word of each pair. Let the child flip the flashcards down revealing new words. Randomly shift speaking the first and second words of the pair so that the child develops ability to detect a word from the vowel pattern appearing on the Visualizer screen.

3. Self-monitoring of [ɑ] and [i]: Instruct the child to produce the word pairs while watching the Visualizer screen. Begin with the expressions "ah" and "ee." Analyze the child's articulation and use all multi-sensory or explanatory approaches which you think may help him produce an accurate vowel sound. The child should have success with the [ɑ]. If the sound is nasalized, repeat some of the previous activities contrasting [ɑ] and [m]. Suggestions to use a wide mouth opening usually results in an acceptable [ɑ] sound.

The small "curls" of the [i] pattern represent the second formant frequency of the sound. The critical factor in producing these features of the pattern is the high-arching of the tongue at the front of the mouth. Use all possible multi-sensory clues and explanations to help the child obtain the high-front tongue position. The resulting [i] pattern should reinforce the child's articulatory behavior on future productions of [i].

Instruct the child to speak the contrasting [ɑ] and [i] words of the flashcards, while monitoring his productions on the Visualizer.

To provide auditory feedback for the child, place the headsets snugly over the child's ears. Let the child adjust the Visualizer volume control to a comfortable level for hearing his own voice.

4. Review: Shuffle the [ɑ] and [i] flashcards into a single pile. As the child says each word, he monitors his production of the [ɑ] or [i] of the word on the Visualizer. Additional flashcards for review may be prepared from the following list of words.

tree
mop
sleep
park
read

deep
not
hot
shop
meat

beans
peas
pot
people
teapot

Materials for Other Vowel Pairs

The following paired words and review words are designed for other word contrasts in order to improve a child's vowel quality. The procedures outlined in the illustrative approach for vowels apply to each contrast pair. It should be kept in mind that the Visualizer patterns are related to the formant frequencies. All multi-sensory clues should be used to provide instruction in jaw, lip and tongue position. The Visualizer is apparently effective in reinforcing the correct tongue position.

Contrasting [ɑ] and [u]:

mop - moo
park - Pooh
car - coo
top - two
pot - pool
mop - moon
box - boots
yarn - you
car - zoom
sock - suit
spot - spoon
star - zoo

Additional review words:

barn
blue
clock
not
rod
watch
shoot
hot
news
march
stop

Contrasting [u] and [ɛ]:

boo - bed
two - tent
do - desk
new - nest
shoe - shell
you - yell
smooth - smell
room - red
who - head
boots - bell
pool - pen
food - fell
two - ten
moon - men

Additional review words:

bread
tooth
spoon
sled
school
red
broom

Contrasting [ɑ] and [ɛ]:

far - fell
ha - head
star - sled
not - nest
barn - bed
top - ten
ma - men
rod - red

Additional review words:

tent
belt
car
dress
jet

clock
arm
bread
yes
socks

said
send
are
seven
cobweb

Contrasting [o] and [ɛ]:

oh - eh
bowl - bell
no - nest
show - shell

smoke - smell
throw - thread
no - Ned
phone - fell

toe - ten
boat - bed
road - red
goat - get

Additional review words:

dress
bow
sled

belt
coat
yes
go

hello
Jello
yellow

Contrasting [o] and [i]:

sew - see
rope - read
grow - green

toe - tea
hoe - he
slow - sleep
more - meat

no - knee
road - read
boat - bee

Additional review words:

soap
eat
coke
three

mow
key
leaf
comb
go

zero
tree
throw
blow

Contrasting [ɑ] and [o]:

ah - o-e
sock - sew
ha - hoe
rod - road

not - no
got - goat
park - pole
barn - bone
top - toe

box - boat
not - nose
car - coat
farm - phone

Additional review words:

show
far
rope

cold
throw
hot
star

father
bravo
follow

Contrasting [o] and [u]:

bow - boo
hoe - who
soap - soup
boat - boot

toe - two
no - new
phone- food
nose - news
blow - blue

home - who
show - shoe
go - goose
cocoa - cuckoo

Additional review words:

fruit
road

goat
school

snow
over

Contrasting [i] and [ɛ]:

ee - -e-

eat - egg
key - get
tea - ten
bee - bed

peach - pen
whe-e-e - wet
we - web
feel - fell

wheel - well
tea - tent
me - men
read - red

Additional review words:

please
sheep
smell

dress
jet

flea
beach
pencil

Contrasting [u] and [i]:

oo - ee

two - tea
suit - seat
tooth - teeth
moon - me

Sue - see
shoe - she
food - feed

spoon - peel
roof - read
school - ski
who - he

Additional review words:

please
soup
tree

sleep
blue
wheel

fruit
meat
three

Review of Five Vowels

The following lists are phonetically similar words for all five vowels used in the previous teaching. It is suggested that the five photographs be arranged in the order indicated in front of the Visualizer and that children speak all five words with contrasting vowels but otherwise similar phonetic environments.

[u]	[i]	[ɑ]	[o]	[ɛ]
two	tea	top	toe	ten
.oo	eat	arm	oh	egg
food	feel	farm	phone	fell
cool	key	car	cold	get
moon	me	mop	mole	men
boo	bean	barn	bone	Ben
rude	read	rod	road	red
who	he	ha	hoe	hen
Sue	see	sock	sew	sell
shoe	she	shop	show	shell
new	knee	not	no	nest
boot	beet	box	boat	bed

Review Phrases for Vowels

The vowel of the stressed word or words in each of these phrases can be monitored on the Visualizer screen. The teacher can display the photographs in front of the Visualizer and the child can monitor his production of one or two stressed vowels as he speaks the phrase with normal speech rhythm and stress. Encourage normality of rhythm and stress rather than excessive prolongation of the vowels being monitored.

a green shoe
a blue seat
go to the movies
eat soup
you and me
show me
go home
oak leaf
see the moon
meat loaf and bread
two teeth
a green star
a red star
a teapot
a green balloon
sleep in a bed
he reads
stop - go
carkeys
more meat, please

go to sleep
bees in a tree
eat eggs
a blue star
the three bears
a red seat
coat and dress
shoes and socks
he sees a boat
I see a car
two men
red, blue and green
three cars
two boats
pen and pencil
hot and cold
snow suit and boots
yes or no
a yellow coat

Use of the Visualizer with Special Problems

1. *Problems of duration and rhythm*. Many deaf children tend to prolong speech sounds excessively, separate the phonemes of the word by pauses, and produce additional syllables, (for example, *school* becomes [sə ku ʌl]. While the Visualizer is not a duration indicator,it is possible to illustrate duration by contrasting plosive and continuant sounds such as [p-f] [t-s] [b-m]. Also, the rapidly changing patterns of connected speech can be demonstrated. This demonstration can be supplemented by an awareness that there are no pauses between sounds. By using monosyllabic words and stressing the vowel so that the pattern can be detected, it is possible to demonstrate that only one syllable is used. Normal duration and rhythm can also be demonstrated by babbling repetitive syllables, but changing the vowel sounds from one syllable to another. If children have difficulty in prolonging a sound, the Visualizer can be helpful, since the visual patterns are more readily identified when prolonged.

2. *Vocal intensity and breathiness*. In order to produce a distinct Visualizer pattern, a vowel must be spoken with adequate vocal intensity and without breathiness. A weak vocal intensity will result in a pattern of small diameter. A very loud pattern produces a squared pattern because of overloading. Within a range of normal vocal intensities, an automatic volume control maintains a stable pattern size. Thus, children can be encouraged to increase or decrease vocal intensity in order to produce a pattern of appropriate size. Breathiness produces an indistinct pattern. The contrast between breathiness and clear voice quality can be demonstrated readily.

3. *High pitch level*. Children whose voices are high pitched will produce a circle with the Visualizer without any distinguishing features of the individual vowels. It is suggested that pitch level training using all possible approaches be used with the [u] vowel. As the child produces an [u] at an appropriate pitch level for him, the [u] pattern will be observed to include the inner circle characteristic of the sound.

4. *Confusion of voiced and unvoiced consonants*. The Visualizer distinguishes between all voiced and unvoiced cognates, although model photographs have not been provided for all of them. The teacher can demonstrate differences between [ʃ-ʒ] [θ -ð] [tʃ-dʒ] and between the plosives [p-b]]t-d] [k-g]. The unit is particularly helpful in calling a child's attention to any tendency to add a vowel after a plosive.

5. *Coping with discouragement*. Some children become discouraged with unsuccessful attempts to perform speech-motor tasks, whether or not the Visualizer is used. They become more discouraged if the Visualizer continually informs them that they are "wrong." The recommended program for the Visualizer presented earlier in this

section is based on reinforcement of successful performance. If the child seems not to be succeeding, the teacher may shift to vocal patterns and sounds which the child uses. By imitating the child's patterns, the teacher can encourage changing vocal patterns which the child can produce successfully. As the child succeeds, he is encouraged to experiment with other patterns, possibly with non-speech noises in a game approach. No photographs of patterns are necessary for these activities.

Additional Suggested Uses

1. The Voice Visualizer can be used by teachers of the deaf in classroom situations, such as group instruction in speech. Then, while the class is engaged in seat work, the teacher can select, for individual attention, children who had demonstrated certain speech problems, using the Visualizer as a supplemental aid.

2. Self-practice sessions can be devised. Any child who has demonstrated some success with a contrasting pair of sounds can go to a booth in a corner of the classroom where the Visualizer is placed. He can practice by himself using the photographs as models, the flash cards as stimuli, and the Visualizer for self-monitoring.

3. Development of voice in young children. The Voice Visualizer has been used successfully with four year old children. It is suggested that it might be used successfully with even younger children. The patterns do motivate children to produce more vocalizations and speech sounds. The difference between breath and voiced sounds can be demonstrated by blowing across the microphone and then by vocalizing any vowel with normal vocal intensity. Non-speech vocalizations and noises produce varying patterns which intrigue young children.

Babbling [bɑ-bɑ-bɑ-bɑ] etc. will produce distinct patterns of the vowel [ɑ]. The spontaneous vocalizations of young deaf children tend to produce good vowel sounds and the Visualizer may be able to reinforce the good vowel quality. The vowels [ɑ] [i] and [u] can be used in babbling, in combination with any plosive consonant. Babbling can also include alternation among the vowels produced. Eventually, the babbling can be converted into words using the consonant-vowel combinations.

IV. DISCUSSION

While this project was successful in the development of a prototype model of the Voice Visualizer which was compact, stable, and easily used by children and teachers, and in the development of a manual of materials and teaching procedures, the method of evaluating the experimental program did not yield definitive answers to some of the questions posed in the purposes of the project. Although the experimental groups showed significant improvement in articulatory proficiency when listeners were asked to judge whether improvement had occurred, there was little improvement in the intelligibility of the test words spoken by the deaf children, although the consonant group did improve more than the vowel group.

It had been assumed that individual differences in the amount of improvement might be explained clinically by case study information. However, no distinctive individual differences in the amount of improvement occurred, except between the consonant and vowel groups, such that no trends within groups could be related to specific case study information. This may be due in part to the nature of the group selected. The two experimental groups were deliberately selected to include children with poor speech and severe hearing losses, but normal intellectual functioning. The case studies did reveal additional environmental and emotional factors which may contribute to the children's poor speech and also inhibit improvement in the formally structured program used with the Visualizer.

The results of the experimental program indicate that visual monitoring of speech production with the Visualizer cannot, by itself, insure significant changes in intelligibility of speech with deaf children similar to those used in this sample. That data do, however, reveal that improvement does occur, and most significantly in the first month of use of the Visualizer. These results suggest that the unit may be more effective as a motivator for children to modify their speech. The data of the study does not provide any information relative to the extent to which the children in the study could use the acoustic information displayed on the Visualizer screen to modify their production of the experimental phonemes. However, a spectral analysis conducted on a few selected phonemes does suggest that the children in the vowel group did begin to produce second formants.

The visual perceptual ability of deaf children has been considered as a possible factor influencing the children's ability to utilize the information of the Visualizer. One factor included in the study, therefore, was a pre-teaching session to insure that the children could match visual patterns, including those produced on the visualizer. All children succeeded in this task, although it must be recognized that these tasks involved static, isolated patterns rather than the moving patterns of a whole word where the phoneme being monitored must be discriminated from among other patterns changing rapidly. Another measure of visual perceptual ability was attempted by administration of the Frostig. and the Ayres Space Perception Test. The scores on these two tests did not correlate with each other for the sample of deaf children used and it was deemed inappropriate to use the data. Other measures of visual perception must be developed for the particular tasks required in self-monitoring of speech by visual feedback.

The data reveal greater improvement in the consonant than the vowel group, which may be due in part to the distinctive nature of consonant patterns on the Visualizer and the fact that more non-Visualizer information could be presented visually, tactually and kinesthetically by the research teacher to aid the child in correct production of a speech sound.

In both consonant and vowel groups, there appeared to be less improvement in control words during the first 5-week period. However, during the rest of the time, the control words improved at the same or at a greater rate. This could be due to some generalization as well as the effect of the word drills without the Visualizer. It should also be noted that after the initial improvement, both groups dropped in terms of listeners' preferring the latter test word. Therefore, the later improvement in control words appears greater, but does not necessarily indicate that the control words were closer to "good speech." The results from the control words support the rest of the data in terms of pointing out the effectiveness of the Visualizer over a short period of time.

The inclusion of an "Advanced Speakers'" Group provided data suggesting that the Visualizer may be more useful in the refinement of articulatory proficiency than in the development of speech in deaf children. This group made significantly greater improvement than the two experimental groups in the short time of five sessions in two and one-half weeks.

The experience of the research staff in the current study suggests that the Visualizer may be more effective when used in conjunction with the regular classroom or tutoring program of speech for the deaf, and then primarily for refinement of speech and reinforcement of correct phonemic productions which have been learned by multi-sensory teaching approaches. The use of minimal-pair words coupled with a total speech stimulation program appears to be a valuable approach for the use of the Visualizer.

V. CONCLUSIONS AND IMPLICATIONS

1. Both the vowel and consonant groups showed articulatory improvement as measured by listener preference.

2. The greatest improvement appeared to be during the first five weeks.

3. Among the children with severe hearing losses and poor speech, there was little change in intelligibility.

4. There was an improvement in intelligibility among the advanced speakers' group, suggesting that the Visualizer may be more effective in speech refinement.

5. The teaching program based upon minimal paired words appeared effective.

6. The Visualizer's stability and portable nature make it feasible as a classroom supplement to developing good speech through visual feedback.

7. Additional research with different experimental designs is required to determine the specific contribution which visual feedback of acoustic information can make to self-monitoring of speech.

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VII. APPENDIXES

A Story Approach Contrasting (b) and (m)

BATMAN

Materials:

Picture of Batman
Model of Batman
(Batmobile)
(Motorbike)
(Bomb)
Flash cards

Story:

BOOM, the bomb missed Batman as he swung from his room. The moon shone on his belt, boots and mask. He climbed into his batmobile. VOOM-M-M. He roared after the two mean men on the motor bike. Batman caught the men and made them take the money back to the bank.

Visual Perception Drill:

Place flash card of bat and man on tray. Child watches Visualizer screen. Teach him to point to the word you say by watching the pattern of the beginning of the word.

Print each of the following word-pairs on flash cards. Place cards on tray below Visualizer screen. In succession, show each of the following flash cards. Instruct child to watch Visualizer screen and point to the word you say. Randomize the stimulus word among first and second words on flash card. Prolong your m sound in the word slightly, so the pattern is easily perceived.

boot - moon
boom - moon
back - mask
money - bank
motor - bike
bat - mobile
take - them
room - rope

Place two small photographs of (m) pattern on opposite sides of the Visualizer screen. Instruct child to watch the Visualizer screen as you say:

moon (point to initial position)
boom (point to final position).

Instruct the child to point to the initial or final position picture as he watches the Visualizer screen.

mask
money
room
mean
room
bomb
men

from
motor
missed
made
climn
boom
moon

Visualizer Drill:

Contrast patterns of b and m using words boom and voom-m-m. Prolong m on voom-m-m, then drill on boom. (Picture of m pattern on rack).

Child practices m-m-m, then say Voom.

Child practices the following word pairs, watching to match m with pattern by prolonging m.

bat	man
bat	mobile
boot	moon
back	mask
money	bank
motor	bike
take	them
rope	room

Child reads words from flash cards, monitoring speech production against photograph of m pattern.

man
mean
motor
missed
moon
mask
money
men
made

milk
mouth
match
map
meat

room
boom
voom
come
home
arm
whom
climb
bomb

foam
seem
bum
tame
same

batman
batmobile
mailman

money back
made them
motor bike

come home
money belt
the bomb missed
two mean men

APPENDIX B

Procedure for Visual Pattern-Matching Tasks

Task I Matching of large and small geometric shapes.

□ ○ △ ⬭

1. Match small picture (stimulus card) to appropriate large picture arranged as above.
2. After each of child's responses, tell child whether response was correct or wrong. Remove small picture from tray.
3. Use scoring sheet for sequence of stimuli.
4. Continue until learning criteria of five out of six consecutive correct matchings has been met.
5. If the child does not meet criteria in 20-stimuli, move to next task.

Task II. Matching of large and small circular patterns.

Same procedure as for Task I.

Task III Matching large and small Visualizer patterns.

(a) Consonant Group- Pictures of [m] [f] [l] [z]
(b) Vowel Group - Pictures of [m] [ɑ] [i] [u]

Same procedure as for Task I.

Task IV Matching small pictures to Voice Visualizer Pattern produced by teacher. (Consonant or Vowel Group)

1. Place small visualizer pictures on tray. Teacher produces a stimulus pattern and child designates matching picture.
2. Use same sequence and procedure as for Task III.

Task V Permit child to vocalize and attempt to match stimulus pictures. Do not reinforce responses with comments. Permit few attempts, using this activity only as motivations for future sessions.

Visual Pattern-Matching **Score Sheet - Task I**

Child's Name____________________________ **Date**________________

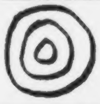
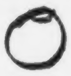
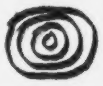
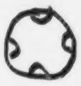
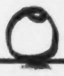
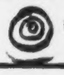
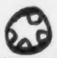
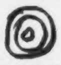
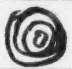
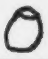
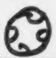
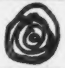
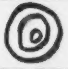
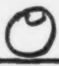
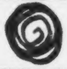
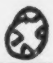
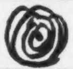
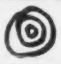
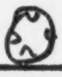
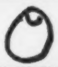
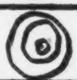
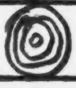
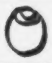
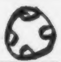
Check the response the child makes for each stimulus picture.

Stimulus		Response			
		□	○	△	⬭
1	□				
2	△				
3	○				
4	□				
5	⬭				
6	△				
7	○				
8	□				
9	○				
10	⬭				
11	△				
12	□				
13	○				
14	⬭				
15	□				
16	△				
17	⬭				
18	○				
19	□				
20	△				

Visual Pattern-Matching Score-Sheet - Task II

Child's Name________________________________Date______________________

Check the response the child makes for each stimulus picture.

Stimulus		Response			
					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Visual Pattern-Matching

Score Sheet - Task III
(Consonants)

Child's Name________________________ Date__________________

Stimulus (Small Picture)	Response (Large Picture) m	f	z	1
1 m				
2 z				
3 1				
4 m				
5 f				
6 1				
7 f				
8 z				
9 f				
10 m				
11 z				
12 1				
13 m				
14 f				
15 1				
16 z				
17 m				
18 1				
19 z				
20 f				

Visual Pattern-Matching

Score-Sheet - Task IV
(Consonants)

Child's Name ______________________ Date ______________

Stimulus (Teacher's Pattern On Visualizer)		Response (Small Pictures)			
		m	f	z	l
1	m				
2	z				
3	l				
4	m				
5	f				
6	l				
7	f				
8	z				
9	f				
10	m				
11	z				
12	l				
13	m				
14	f				
15	l				
16	z				
17	m				
18	l				
19	z				
20	f				

Visual Pattern-Matching

Score Sheet - Task III
(Vowels)

Child's Name__________________________ Date______________________

Stimulus (Small Picture)	Response			
1 m				
2 u				
3 i				
4 m				
5 a				
6 i				
7 u				
8 a				
9 m				
10 i				
11 a				
12 u				
13 m				
14 i				
15 u				
16 a				
17 u				
18 m				
19 i				
20 a				

Visual Pattern-Matching

Score Sheet - Task IV
(Vowels)

Child's Name____________________________Date_______________________

Stimulus (Teacher's Pattern of Visualizer)	Response (Small Pictures) m	 a	 i	 u
1 m				
2 u				
3 i				
4 m				
5 a				
6 i				
7 u				
8 a				
9 m				
10 i				
11 a				
12 u				
13 m				
14 i				
15 u				
16 a				
17 u				
18 m				
19 i				
20 a				

APPENDIX C

Teacher's Rating Scale

Please indicate your impression of ____________________________'s level of functioning in the following areas by circling the appropriate number:

1. below-average functioning relative to functioning of deaf children for this class level.
2. average functioning relative to functioning of deaf children for this class level.
3. above-average functioning relative to functioning of deaf children for this class level.

INTELLECTUAL FUNCTIONING	1	2	3
LEVEL OF LANGUAGE FUNCTIONING			
VOCABULARY			
LIPREADING (with auditory)	1	2	3
READING	1	2	3
SPOKEN	1	2	3
WRITTEN	1	2	3
SENTENCES			
LIPREADING (with auditory)	1	2	3
READING	1	2	3
SPOKEN	1	2	3
WRITTEN	1	2	3

APPENDIX D

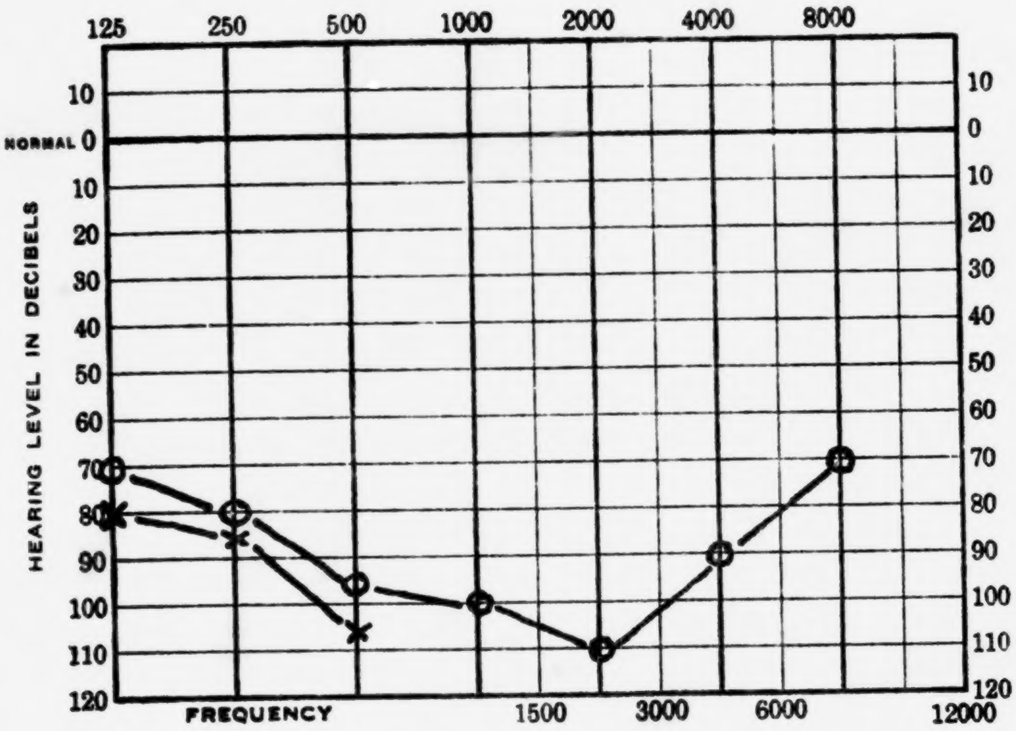
Case Study Information

Alan   Consonant Group   C.A. 7-1

Family and Environment

Alan is one of five children and has two brothers and two sisters. His ten year old brother is deaf also and attends school with Alan. The family lives in a modern ranch-style house located in a residential area about 25 miles from Boston. Alan's father is a skilled laborer.

Audiogram



History of Deafness

Alan's deafness is apparently inherited. In addition to his own brother who is deaf, he also has an uncle who is deaf.

Response to Environmental Auditory Stimuli

At home, Alan only responds to gross sounds, while at school, he is able to discriminate between gross sounds.

Health and Physical Status

He was hospitalized twice in infancy, once at 3 months for removal of a growth on his back and once at one year for a severe staph infection in his right ear. He is now in very good health, though like his ten year old brother, he is somewhat small for his age, both in height and in build.

Visual Perception

Alan's z scores on the Ayres Space Test and the Frostig Developmental Test of Visual Perception were 13 and 15 respectively. He ranked twenty-first out of 24 on a combined group rank of performance on the two tests.

Intellectual Functioning

Tests results recorded in his school folder indicate that he is functioning at an average level intellectually.

Pre-School Battery	Gesell Drawing Test	Goodenough Draw-a-Man
C.A. 4-3	C.A. 4-3	C.A. 4-3
M.A. 4-6	M.A. 4-6	M.A. 4-6
	I.Q. 106	I.Q. 106

His present teacher's impression correlates with the above results, and his school record indicates average performance. One of the youngest members of his class, he has been promoted regularly.

Education

Alan attended a nursery program for pre-school deaf children for a year before entering the school for the deaf two months prior to his fourth birthday.

Communicative Behavior - parent's report

At home, he uses very little gesture language, and communicates primarily by speech and lipreading.

Communicative Behavior - teacher's report

According to his teacher, Alan is performing at an average level in all aspects of verbal communication, lipreading, reading, speaking and writing.

Psycho-Social Behavior - parent's report

His mother reports that he is well accepted by the children in the neighborhood and that he readily joins into any outdoor activities with them. "He is always on the go." His mother feels that he has not been doted upon exceedingly, and attributes this to the fact that he is not the first deaf child in the family.

Psycho-Social Behavior - teacher's report

According to his teacher's ratings on the Pupil Behavior Rating Scale, Alan shows no maladjustive behavior in school. He appears to have difficulty concentrating after a short period of time.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Alan's voice was weak and thin. Pitch was monotonous and often above his normal range. Considering his hearing loss, however, voice quality was fairly good. Though his speech was often intelligible to the research teacher when visual and contextual clues were present, an analysis of individual phonemes in words indicated that most of his sounds were distorted or omitted. Observation of his articulation of the experimental sounds revealed: [b/m], [[illegible]/r], omission of [s] and [z], distortion of [f] [v] [l] [n] and [θ].

Observations of Behavior during Sessions

Alan found it more difficult than most to prolong the phonemes enough to be seen for monitoring; this was particularly true of the [m] and [l] patterns. He was generally cooperative and seemed to put forth a great effort to do well. However, his attention span was limited and he found it difficult to concentrate on the Visualizer patterns for longer than a few minutes at a time. He often repeated and paired stimulus words over and over in a robot-like fashion, watching the screen but not monitoring his speech. His performance varied directly with his capacity to attend during any particular portion of a session. Rapport with the research teacher was generally good; communication was primarily by speech. Alan was able to lipread simple phrases easily.

Observation of Changes in Alan's Speech

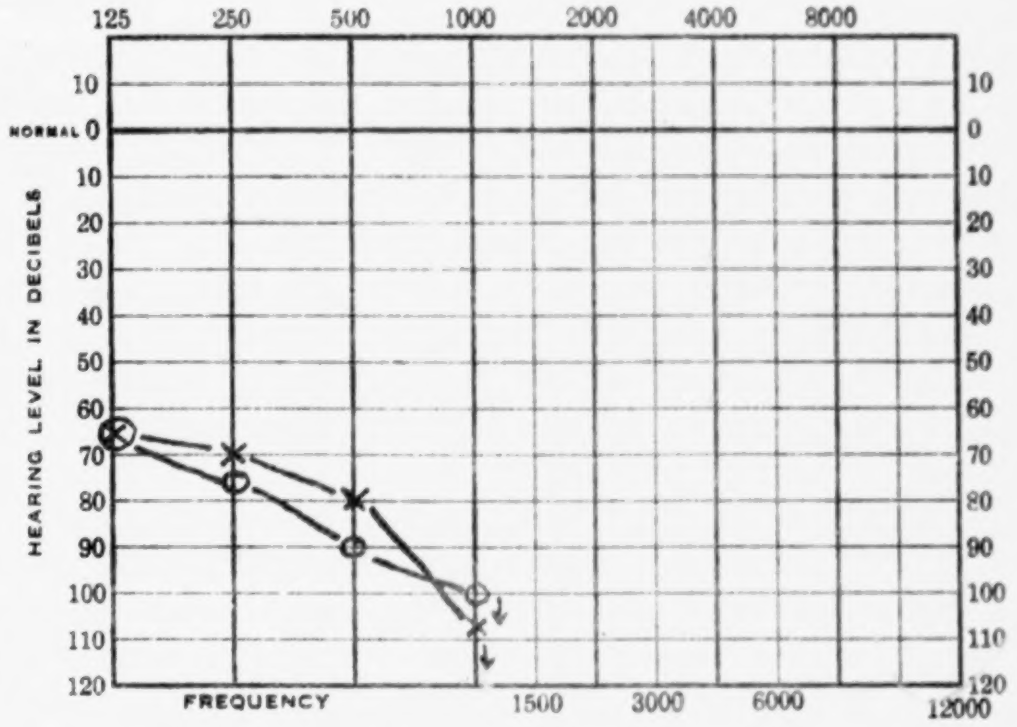
The following changes were observed in Alan's speech, though with a high degree of inconsistency, during the experimental period: reduction of occurrence of [b] in transitions from [m] in initial position, reduction in omission of [s], reduction of distortions of [s] [v] [l] and [n]. Increase of voice and friction in [z] was observed but not maintained. No change was observed in his production of [f]. Alan's voice quality remained relatively unchanged. He learned how to monitor his speech to a normal level but was not always able to execute this change when called for.

Bobby Consonant Group C.A. 7-2

Family and Environment

During the week Bobby boards at the school for the deaf, where his mother is school nurse; on weekends and vacations he is at home with his mother and older (hearing) sister.

Audiogram



History of Deafness

Bobby was apparently born deaf. His mother was ill throughout the pregnancy, but exact etiology of the deafness has never been determined. The hearing loss was first suspected when Bobby was nine or ten years old.

Response to Environmental Auditory Stimuli

According to his teacher, Bobby responds to loud sounds, and can discriminate gross sounds and a few phrases.

Health and Physical Status

He is in sound health and physical condition.

Visual Perception

Bobby scored high on both the *Ayres* and the *Frostig*. His z scores on the two tests were 95 and 44 respectively, and he ranked first out of 24 on a combined group rank of performance.

Intellectual Functioning

Scores recorded in Bobby's school folder indicate that he was functioning above average intellectually, as a pre-schooler.

Pre-School Battery		Gesell Drawing Test		Goodenough Draw-a-Man	
C.A.	4-3	C.A.	4-3	C.A.	4-3
M.A.	5-3	M.A.	5-10	M.A.	5-3
		I.Q.	117	I.Q.	123

It is the impression of Bobby's present teacher that he is functioning on an average level intellectually. His school record indicates average performance.

Education

Bobby began attending the school for the deaf one day a week, at C.A. 3-10. Now in his fourth year in school, he is in grade 1A.

Communicative Behavior - parent's report

Bobby's mother reports that he communicates by a combination of speech and gestures at home but that, when pressed, he will use speech exclusively.

Communicative Behavior - teacher's report

According to his teacher, he is functioning on an average level in verbal language, both receptively and expressively.

Psycho-Social Behavior - parent's report

Bobby gets on well with the hearing children in his neighborhood and particularly enjoys playing with his hearing cousins. He likes participating in any boy's outdoor game, as well as watching television. He tends to be outgoing even with people whom he does not know.

Psycho-Social Behavior - teacher's report

The teacher reports that Bobby shows no maladjustive behavior in school. He likes to play hard and is generally a lively and outgoing boy.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Bobby's voice was high-pitched but had a relatively natural quality. Inflection and speech rhythm were good considering his hearing loss. On the experimental sounds, distortions were present in [m] [v] [l] [r] [n] and [θ], and substitutions were presented in [t/s] [d/z] [v/f]. His speech was not generally intelligible to the research teacher without some visual clue.

Observations of Behavior during Sessions

Bobby was lively, active and enthusiastic during sessions, but his enthusiasm was not always directed toward the *Voice Visualizer*. At times, he was extremely playful and either could not or would not settle down or give his attention to the task at hand. When motivated to concentrate though, either by the spirit of competition with his friend, Eric, or by the anticipation of a reward, his performance in monitoring was very good. Bobby appeared to be completely uninhibited in his attitude toward communicating with the research teacher. He relied primarily on speech and lipreading, but used writing and gesturing as supplements when he failed to make his thoughts known through speech. (He loved looking at the pictures of Batman and Robin and asked to work with these words in every session, always expending much effort when working with these words.)

Bobby liked to move very quickly through the materials and often resented taking the time to monitor each word pair visually. The patterns, while initially fascinating to him, became less interesting and he preferred looking at the picture materials to watching the Visualizer screen. He often initiated conversation in relation to the picture materials and occasionally, words containing Visualizer sounds arose in his conversation and were monitored. Bobby seemed to show considerably more interest in monitoring these naturally occurring words than in monitoring the structured minimal pairs.

Observations of Changes in Bobby's Speech

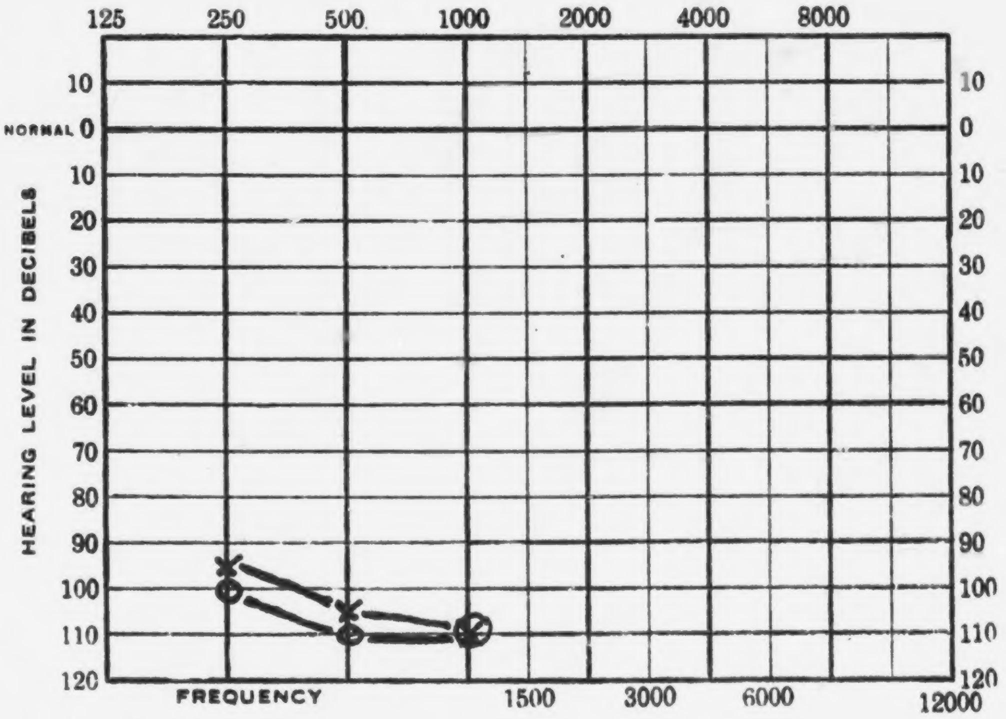
The most striking changes in Bobby's speech occurred in his productions of [z] and [l]; the reduction of distortions in these two sounds was considerable. Also observed were reductions in the distortions in [v] [f] [m] [n] and [θ], reduction of omission of plosive sounds, increase in the difference made between [s] and [t], and reduction in distortion in pitch level. No change was observed in [r].

Charles Consonant Group C.A. 7-5

Family and Environment

Charles and his parents and his three younger siblings, including a new baby, live in a small four-room apartment in a lower middle class residential area. The family is planning to move to a larger apartment later this year. Charles' father works as an unskilled laborer. Charles boards at the school for the deaf during the week and spends weekends at home.

Audiogram



History of Deafness

Charles was apparently born deaf. Throughout the pregnancy, his mother had headaches and continual periods of nausea; in the third month of pregnancy, she hemorrhaged for one day. Deafness was first suspected when Charles was nine months old.

Response to Environmental Auditory Stimuli

His teacher reports that he responds to loud sounds and is able to discriminate a few phrases.

Health and Physical Status

Outside of his deafness and poor teeth, Charles is in excellent physical condition. When he was 18 months old, he was severely burned and was hospitalized, then and six months later, for skin grafts. He was hospitalized when he was 4 1/2 years old for removal of his tonsils and adenoids. He has otherwise been in good health.

Visual Perception

Charles scored low on both the Ayres and the Frostig: his z scores were 17 and 0 respectively, placing him 23rd out of 24 in a combined group rank.

Intellectual Functioning

When he was 16 months old, Charles was evaluated by a psychologist whose impression was that he showed good-average ability. Test results recorded in his school folder indicate that he is functioning somewhat inconsistently, but generally within the normal range.

Pre-School Battery		Gesell Drawing Test		Goodenough Draw-a-Man	
C.A.	4-8	C.A.	4-8	C.A.	4-8
M.A.	4-8	M.A.	4-4	M.A.	5-10
		I.Q.	92	I.Q.	107

His present teacher feels that he is functioning on an average level intellectually. His school record indicates average performance on academic tasks.

Education

Charles had three years of individual pre-school training from C.A. 1-3 to C.A. 4-3 for one hour per week by a trained teacher of the deaf. At the end of that period, he was enrolled in the school for the deaf, where after four years, he is now in grade 1B.

Communicative Behavior - parent's report

At home Charles uses gestures to communicate, with very little speech.

Communicative Behavior - teacher's report

His teacher feels he is functioning on an average level in all aspects of verbal language, except lipreading, in which he is functioning above average.

Psycho-Social Behavior - parent's report

Charles has presented a problem of discipline and control at home, reported as early as 16 months of age. His boarding at the school for the deaf resulted from his parents' inability to manage and discipline him at home. His mother often finds him aggressive and often unmanageable. He likes to play outside "all the time" when he comes home over the weekend, but the children in the neighborhood do not accept him because he is "bossy." They will not play with him unless he has something they want to play with.

Psycho-Social Behavior - teacher's report

Past teachers' reports indicate that Charles is often hyperactive and aggressive. Impressions were that he responded better in structured situations where goals and limits were explicit. His present teacher reports that quite often he gets into fights or quarrels with other children, but that in spite of that tendency he is, with respect to the other pupils in the class, one of the two children with the best mental health.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Charles' voice was distorted by intensity above the normal range and by abrupt and uncontrolled changes of pitch. Speech rhythm was also distorted. An initial analysis of his speech revealed numerous distortions, including distortions of [f] [v] [r] [n] [θ], substitutions of [b/m], [ɛ/l] and omissions of [s] and [z].

Observations of Behavior during Sessions

Charles was highly distractible during most sessions and was often unable to focus his attention on the Visualizer screen. He was usually eager to get through the materials in order to go outside, continually asking "finished?" He showed little interest in learning how to monitor his speech visually, though he was initially interested by the patterns made on the screen during vocal play. His knowledge of the vocabulary in the materials was scant, and it appeared that he had not yet established a left to right pattern for reading. Generally, he was not receptive to instruction and found the task of focusing his attention on visual monitoring intolerable for more than a few minutes in each session. Charles communicated primarily in one-word phrases which were generally unintelligible to the research teacher without visual clues.

Observations of Changes in Charles' Speech

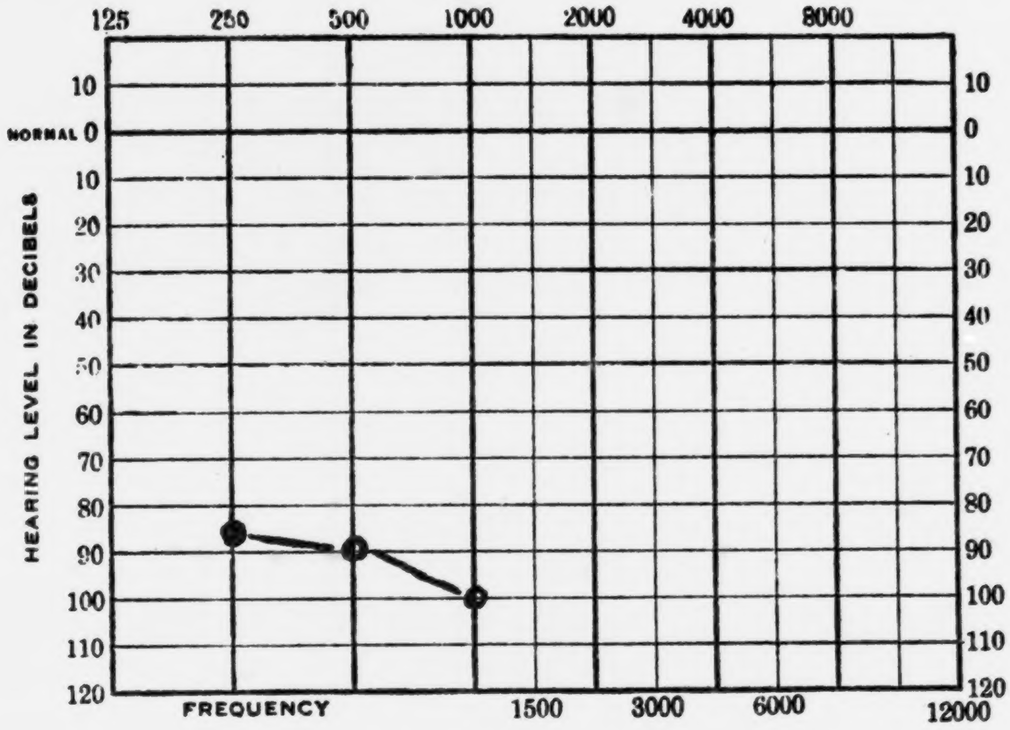
It was the impression of the research teacher that Charles' behavioral pattern during sessions with the Visualizer negatively influenced the degree of change occurring in his speech. The following changes were however observed: reduction of [b/m] substitution and increase in the occurrence of a smooth transition from [m] in initial position, reduction in the distortion of [f] [v] and [θ], and reduction in the omission of [s]. Substantial increase in the frictional and vocal components of [z] was observed during two sessions, but not maintained. No change was observed in [n] [r] or [l], or in Charles' general voice quality.

Donald Consonant Group C.A. 7-8

Family and Environment

Donald is the oldest of three children; his four year old sister and 18-month old brother both have normal hearing. The family lives in a modest well-kept house in a quiet residential community outside of Boston. Donald's father, a machinist, has worked for the past five years as night shift foreman, but a recent change in his work schedule has allowed him to work in the daytime. He is maintaining, however, some part-time employment at night. Donald's mother is at home.

Audiogram



History of Deafness

Deafness was apparently caused by prolonged labor and complications during delivery. The child was born 3 1/2 days after the first onset of labor, though labor was not continuous through the three-day period. Delivery was breach and the child's umblical cord was wrapped around his neck. No post-natal complications were noted. Deafness was first suspected when Donald was 18 months old.

Response to Environmental Auditory Stimuli

Donald's teacher reports that he gives no consistent response to sound.

Health and Physical Status

Outside of the complications present during his delivery and a mild case of scarlet fever when he was three years old, Donald has been in good health. He walked alone at nine months. Donald is a well-built, agile young boy.

Visual Perception

His z scores on the Ayres and Frostig tests of visual perception were respectively: 33 and 60. His combined group rank was 10.

Intellectual Functioning

Results of tests administered when Donald was of pre-school age indicate that he was functioning above average intellectually:

Pre-School Battery		Gesell Drawing Test		Goodenough-Draw-a-Man	
C.A.	4-0	C.A.	3-8	C.A.	3-8
M.A.	5-0	M.A.	4-6	M.A.	4-6
		I.Q.	122	I.Q.	122

His grade report indicates average and above average performance in academic performance. It is the impression of his present teacher that he is functioning on an average level intellectually.

Education

At C.A. 2-2, Donald was enrolled in a state sponsored preschool program for the deaf in which each week he had 1 1/2 hours in individual speech and language therapy. When he entered the school for the deaf at C.A. 3-5, he could use approximately ten words appropriately and spontaneously. He is presently in grade 2B, the appropriate grade level for a normally hearing child of his age.

Communicative Behavior - parent's report

Donald rarely uses gestures at home. According to his mother, he talks a great deal, often stringing four or five words together into phrases. He lipreads well and is usually able to understand words and phrases spoken and seen on television. Donald enjoys reading children's picture books.

Communicative Behavior - teacher's report

Donald's teacher feels that he is functioning on an average level in most aspects of expressive and receptive language, though somewhat below average in written language. It is her impression too that he lipreads unusually well for a profoundly deaf child.

Psycho-Social Behavior - parent's report

Donald is an active child, "always busy, always talking." Though he enjoys outdoor activities, he spends much of his time indoors, helping his mother around the house, playing with his sister, and building with his father in the basement workshop. Before moving to the present location, the family lived in an apartment building where none of the neighboring children would play with Donald because he was deaf. At that time, Donald naturally preferred to play inside with his sister. In the neighborhood in which he presently lives, his hearing peers are permitted to go to the store or to go fishing alone, and since Donald's mother feels he is not old enough to accept such responsibility, Donald continues to play with his sister and also with the girls in the neighborhood. Donald's mother expressed some concern about his interest in typically feminine activities - playing with dolls, make-up, jewelry, etc. - and is encouraging participation in activities with boys in an attempt to offset this tendency.

According to his mother, Donald is quite stubborn and often insistent upon getting his way. "He wants to be first in everything," whether in participation in games and sports or in being served his dinner. He is a meticulous child not only in his appearance, but also in the care he shows when straightening his father's workshop.

Psycho-Social Behavior - teacher's report

According to his teacher, Donald shows no maladjustive behavior. He is an outgoing, talkative child.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Donald's speech rhythm and voice quality were good considering his hearing loss. Analysis of his speech revealed the following: distortions of [v] [z] [n] and [θ], substitutions of [v/f] [b/m] [u/r], and omission of [s].

Observation of Behavior during Sessions

Donald was quick to understand the task of visual monitoring including the prolongation of only the monitored sound. He liked to move very quickly through the materials, but went slowly enough to monitor the sounds visually as called for. After several weeks of working with the Visualizer, he appeared to lose interest in the materials, but though his rate and number of responses seemed to decrease, he continued to watch the Visualizer screen and monitor his speech. He communicated with the research teacher primarily by speech and showed excellent ability in lipreading. He was familiar with most of the words in the materials and demonstrated much interest in those words which were unfamiliar to him.

Observations of Changes in Donald's Speech

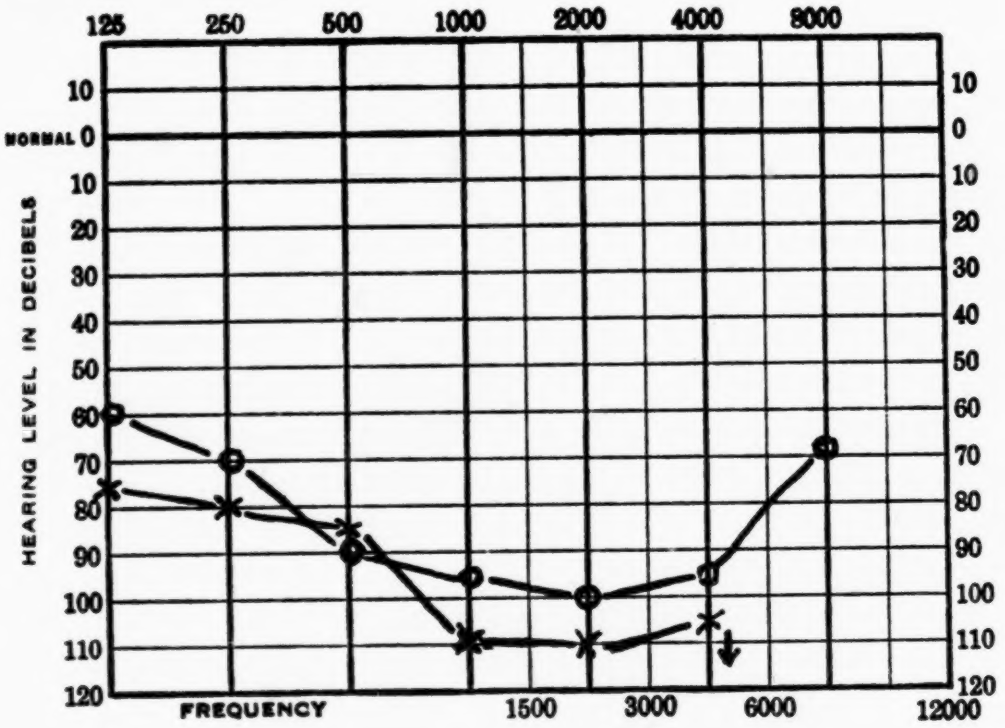
The following changes in Donald's speech were apparent during the experimental period: increase in frictional component and clarity of the [f]; substantial of reduction of omissions of [s], reduction of substitution of [b/m], substantial reduction of distortions of [z] and [v], which, once learned were seldom omitted, and reductions of omissions of voiceless plosives. No change was apparent in either the [r] or the [l]. Donald's articulation of [l] initially was close to the correct production; the [r] remained distorted. With instruction, Donald was able to produce both [0] and [n] well, but often lapsed into incorrect production without reinforcement from the research teacher. It was the impression of the research teacher that, of the 7 consonant Visualizer sounds, Donald's visual monitoring of the voiced and voiceless fricatives [v] [z] [f] [s] called for least additional reinforcement from the research teacher.

Eric Consonant Group C.A. 7-10

Family and Environment

Eric lives with his mother and step-father and three younger half-brothers, ages 6, 5, and 2, all of whom have normal hearing. The family lives in one half of a rather run-down two family house situated in a middle income area. Eric boards at school and spends weekends and vacations at home.

Audiogram



History of Deafness

The etiology of Eric's deafness is unknown. He was apparently born deaf; his hearing loss was discovered at 18 months.

Response to Environmental Auditory Stimuli

According to his teacher, Eric is able to discriminate gross sounds and a few phrases. At home, he responds to loud sounds.

Health and Physical Status

Eric's physical and mental development has progressed at a normal rate. A well-built, well-coordinated boy, he is in excellent health.

Visual Perception

Eric's z scores on the Ayres and the Frostig were 85 and 15 respectively. His combined group rank on the two tests was 9.

Intellectual Functioning

The following test scores are recorded in Eric's folder:

	Pre-School Battery	Gesell Drawing Test	Sequin Board
C.A.	5-1	5-1	5-1
M.A.	6-0	5-6	5 +

	Goodenough Draw-a-Man	Weschler Intelligence Scale for Children Performance Scale
C.A.	5-1	6-8
M.A.	6-0	
I.Q.	116	100

It is the impression of Eric's teacher that he is functioning on an average level intellectually.

Education

Eric was tutored for two years, from the age of 2 1/2 to 4 by a clinical teacher of the deaf. At 4 1/2, he entered the school for the deaf, where he has been promoted regularly and is now in grade 1A.

Communicative Behavior - parent's report

At home, Eric communicates using speech and gestures in combination. His mother reports that "he talks a lot."

Communicative Behavior - teacher's report

According to his teacher, his level of language functioning is average in lipreading, reading and writing in individual words and sentences. Her impression is that in spoken language, he is functioning below average.

Psycho-Social Behavior- parent's report

Eric's mother reports that he has not been accepted in their neighborhood. When the family moved to that location several years ago, the neighbors were quite hostile toward him and asked that he be kept indoors. One of the neighbors worked nights and, during the day when he was sleeping, "didn't like Eric's screaming." According to his mother, Eric was made the scapegoat for any wrong done in the neighborhood. His hearing peers do not play with him because he is bossy, and whereas his brothers like to play outside, Eric prefers to stay around the house, helping his mother.

As a young child, he was extremely stubborn and his parents were advised by a social worker not to pamper him. Gradually, since entering school at 4 1/2, he has become less difficult to manage, and though he did not like his first two years at school, he now has a good friend in his class and enjoys school very much. Eric seems to need a great deal of praise, and always works hard after having been praised.

Psycho-Social Behavior - teacher's report

Eric's teacher reports that he often quite gets into fights or quarrels with other pupils.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Eric spoke in a near natural voice with good inflection and good rhythm. Most of his individual sounds were distorted, however, including the experimental sounds [m] [r] [l] [f] [v] [θ] and [r]. [s] and [z] were omitted.

Observations of Behavior during Sessions

Eric demonstrated a natural flow of spoken language, though in conversation, his speech was generally unintelligible unless he was made to speak less than the normal rate. He used gestures only rarely. He cooperated well, and appeared to put forth a great effort in order to gain approval. His attention to the Visualizer screen varied, though he seemed generally consistent in monitoring his productions of [f] [v] [s] and [z], particularly when the cognates were paired, or when [z] and [v] were paired. Eric often initiated conversation about the pictures in the materials, and was eager for explanations of words which he did not fully understand.

Observations of Changes in Eric's Speech

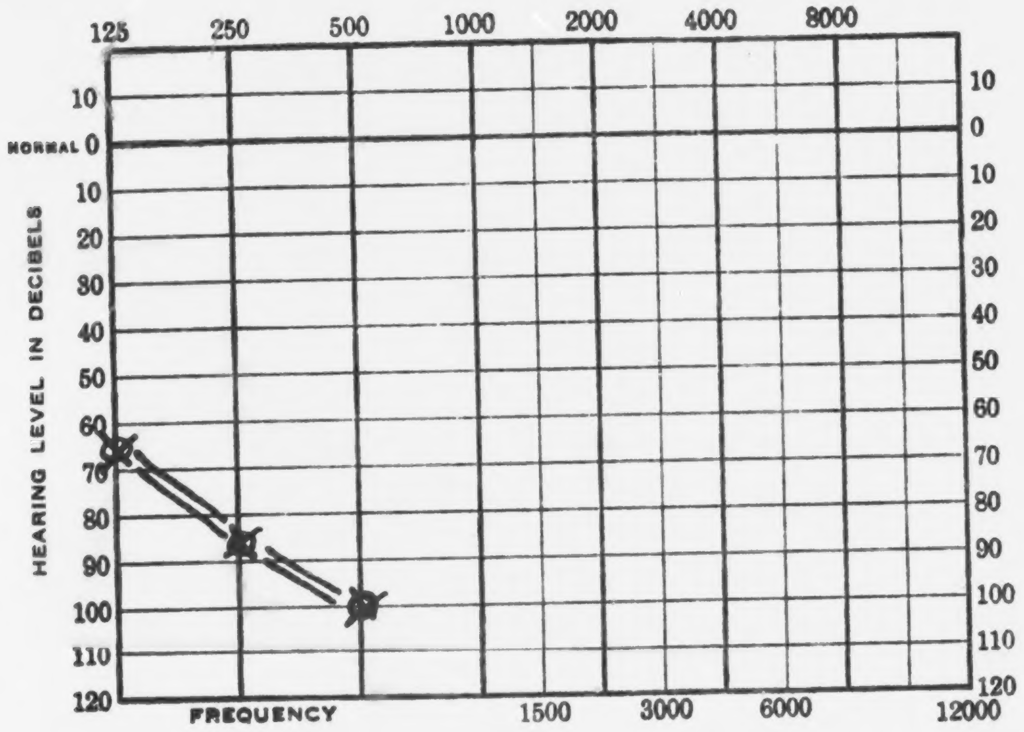
The following changes were observed in Eric's speech when working with the Visualizer: reduction of [b] in transitions from [m] in initial position, increase in frictional component in [f], drastic reduction in omissions of [s] and [z], reduction of omissions of plosives, corrections of the distortions of [v], [θ] and [n], reduction of occurrence of an [n/l] substitution. At one point in the experimental period, Eric developed a tendency toward nasality in all his phonemes. A brief practice session with the Visualizer contrasting the vowels [a] and [u] corrected this tendency.

Fran Consonant Group C.A. 8-1

Family and Environment

Fran is one of six children and is herself an identical twin. She has both older and younger siblings. Her twin sister is an attractive child, and in good health and physical condition. The family lives in a residential area about 15 miles from Boston. Fran's father is a railroad freight conductor.

Audiogram



History of Deafness

Fran was apparently born deaf. Delivery was one month premature, and she inhaled fluid before birth and had to be resuscitated. Deafness was discovered when Fran was 1-9.

Response to Environmental Auditory Stimuli

According to mother and teacher, Fran does not respond to sound, but is aware of vibration.

Health and Physical Status

In addition to bilateral profound deafness, several physical defects were diagnosed during Fran's first year of life. These included congenital strabismus, hypertrophied tonsils and adenoids, scoliosis of the spine, cyanosis, and a condition which caused choking during feeding. As a small baby, Fran was not healthy. She had frequent colds in her first month of life and two episodes of upper lobe pneumonia in her second month. At 2 1/2 months, surgery was performed to divide the tracheo-esophageal fistula; on discharge from the hospital her prognosis, in relation to the surgery, was excellent. At C.A. 3-0, etiology of the scoliosis (which causes her head to turn slightly to the left and her right shoulder to be raised) was found to be hemivertebra at the lower cervical region on the right side. Since this winter, Fran has been wearing a torso brace to the top of her neck; she must continue to wear such a brace through her growing years, in order to prevent her back from deteriorating further. She wears corrective shoes as well. Presently, Fran is frequently troubled by labored respiration, due to congestion in the respiratory system.

Visual Acuity

She wears glasses to correct her vision. The defect in her vision has been diagnosed as congenital strabismus.

Visual Perception

Fran's z scores on the Ayres and the Frostig were 64 and 21 respectively. Her combined group rank was 15.

Intellectual Functioning

Her teacher reports that she is functioning below average intellectually. However, previous reports from her four previous years in school indicate that she has been functioning on an average level intellectually.

Education

Fran attended nursery school for the deaf two mornings a week from the age of three years. She entered the school for the deaf at C.A. 4-10 and is now in grade 1A.

Communicative Behavior - parent's report

At home, Fran communicates by a combination of speech and gesture.

Communicative Behavior - teacher's report

According to her teacher, Fran is functioning on an average level in all forms of verbal communication.

Psycho-Social Behavior - parent's report

She enjoys the usual childhood activities. Her mother states that Fran is beginning to question now why she is different while her twin sister has no abnormalities.

Psycho-Social Behavior - teacher's report

According to her teacher, Fran shows no maladjustive behavior in school. She is very quiet and quite retiring.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observation of Speech and Voice

Fran's voice was low pitched and monotonous, though her speech rhythm was fairly natural. Most of her individual phonemes in words were distorted to some extent, including the experimental sounds [f] [v] [z] [r] [n] [θ] and to a lesser degree [l]. She substituted [b/m] and omitted [s].

Observations of Behavior during Sessions

Fran was quiet and cooperative during sessions with the Voice Visualizer. After several weeks of work, her timidity became less pronounced, and she began to initiate some communication with the research teacher. Her attention to the Visualizer screen was fair for most of the experimental sounds but was noticeably better with the [z] [v] and [s] patterns. Though her speech was unintelligible without some visual clues, she communicated primarily by speech in one-two word phrases. Because of her frequent colds which produced blockage of her nasal passage, it was often impossible to work on the [m]-[b] and [θ]-[n] contrasts or to record accurately Fran's ability to articulate [m] and [n].

Observations of Changes in Fran's Speech

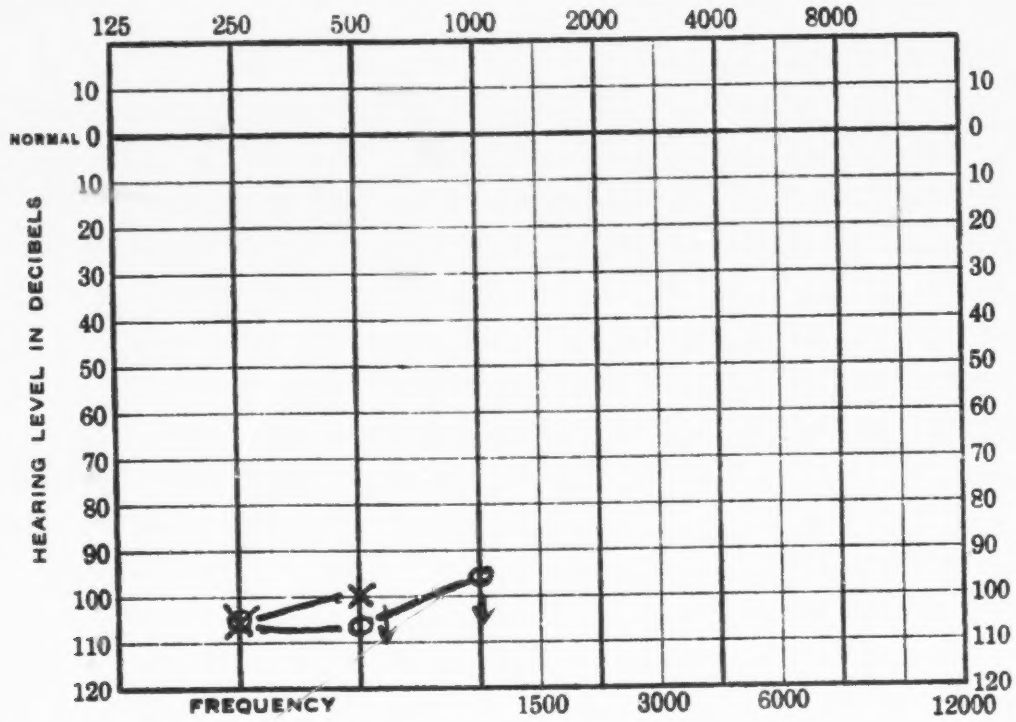
The following changes were observed in Fran's speech: slight increase in frictional component of [f] and [θ], substantial reduction in omissions of [s], reduction of the distortion of [s], increase in voice and friction in [z] and [v], though maintained only in the [v], and reduction of [l] distortion. On those occasions when Fran's nasal passage was clear, she worked on and was able to make a distinction between nasality and non-nasality in [b]-[m] and [n]-[l].

Gail Consonant Group C.A. 8-2

Family and Environment

Gail lives with her parents and three active robust younger siblings (boy-6, girl-4, boy-2) in one of a complex of apartments on a quiet residential street in a small community. Outside of her six year old brother, who is seeing his school speech therapist for an articulation disorder, the mother reports that no other member of the family has had a speech or language impairment. Gail's father, a career service man, was transferred from this area to Philadelphia last fall (October 1966) and since then has been able to see his family only sporadically. The family postponed moving from the Boston area so that Gail could finish her school year without interruption, but after investigating the possibilities for school placement for Gail in Philadelphia, the parents have concluded that Gail's present school is superior to any accessible to her in Philadelphia and so have decided to maintain the present living arrangements.

Audiogram



History of Deafness

The cause of Gail's hearing loss is unknown. She was apparently born deaf, and at 8 months the hearing loss was first noticed.

Response to Environmental Auditory Stimuli

According to her mother, Gail responds to very loud environmental sounds but does not respond to telephone or doorbell or to human voice.

Health and Physical Status

Gail sat up at 8 months and walked alone at 18 months. Until the age of 2 1/2 years, she was "wobbly" on her legs and lost her balance quite easily; doctors informed parents, when Gail was 18-24 months, that she showed an "extremely mild case of cerebral palsy." She has worn and now wears corrective shoes. Gross motor coordination (including gait) and fine motor coordination at this time appear to be within the normal range. In addition to deafness and history of a slow gross motor development, Gail is underweight. Her mother reported that several years ago Gail presented a feeding problem for about a year, but has had no such problem since then. Gail has rarely been sick, but has been hospitalized on two occasions, once at age 6 months to open and brace her prematurely closed fontanel, and again at 6 years for a broken arm.

Visual Perception

Gail's z scores on the *Ayres* and the *Frostig* were 90 and 15 respectively. Her combined group rank was 6.

Intellectual Functioning

Results of tests recorded in her folder indicate Gail is functioning within the normal range intellectually.

Items from Stanford-Binet

C.A. 3-8
All at 3-6 level correct
2 at 4-0 year level correct
4-5 year level performance puzzles
and formboards

Arthur Revision of the Leiter International Performance Scale

C.A. 3-8
M.A. 4-4

Gesell Drawing Test

C.A. 4-2
M.A. 4-0
I.Q. 96

Goodenough Draw-a-Man

C.A. 4-2
M.A. 4-0
I.Q. 96

At C.A. 3-8, Gail was given a psychological evaluation. Impressions were: somewhat dependent but normally responsive child with good attention span and self-critical ability and no indication of intellectual deficiency. Gail's school record indicates average performance in academic subjects, and her present teacher's impression is that she is functioning intellectually at an average level with respect to deaf children of her class level.

Education

After some early training from her mother through the John Tracy Correspondence Course, Gail attended a school at a small town hospital clinic for two years (ages 2-3), where she was given speech therapy. At age 4-0, she entered the school for the deaf where she has been promoted regularly. Now in her fifth year in school, she is in grade 2B.

Communicative Behavior - parent's report

At home, Gail communicates by lipreading and by speaking in one or two word phrases, generally intelligible to her siblings, if not to her mother. Gesture is the usual means of communication between Gail and the children in the neighborhood.

Communicative Behavior - teacher's report

In lipreading, reading and writing, Gail is functioning at an average language level, in comparison with deaf children at her class level; in speaking, her level of language functioning falls below average.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Gail's voice was monotonous and her speech rhythm distorted through excessive prolongation. Initial analysis of her articulation of speech sounds revealed numerous distortions and omissions including distortions of [l] [l] [θ] [r], substitution of[b/m] and omissions of [f] [v] [s] and [z].

Observations of Behavior during Sessions

In sessions with the research teacher, Gail appeared extremely hesitant to communicate and, unless specifically asked a question she rarely made comments. Apparently eager to perform well, she generally fixed her attention on the Visualizer and the structured task of monitoring her speech. She was often observed wringing her hands and holding her body taut, and no attempts to put her at ease resulted in discontinuing this behavior. When she did speak, she rarely used gestures.Though able to lipread simple, common one-two word phrases, she generally appeared timidly confused when any word(s) unfamiliar to her were directed toward her.

Observations of Changes in Gail's Speech

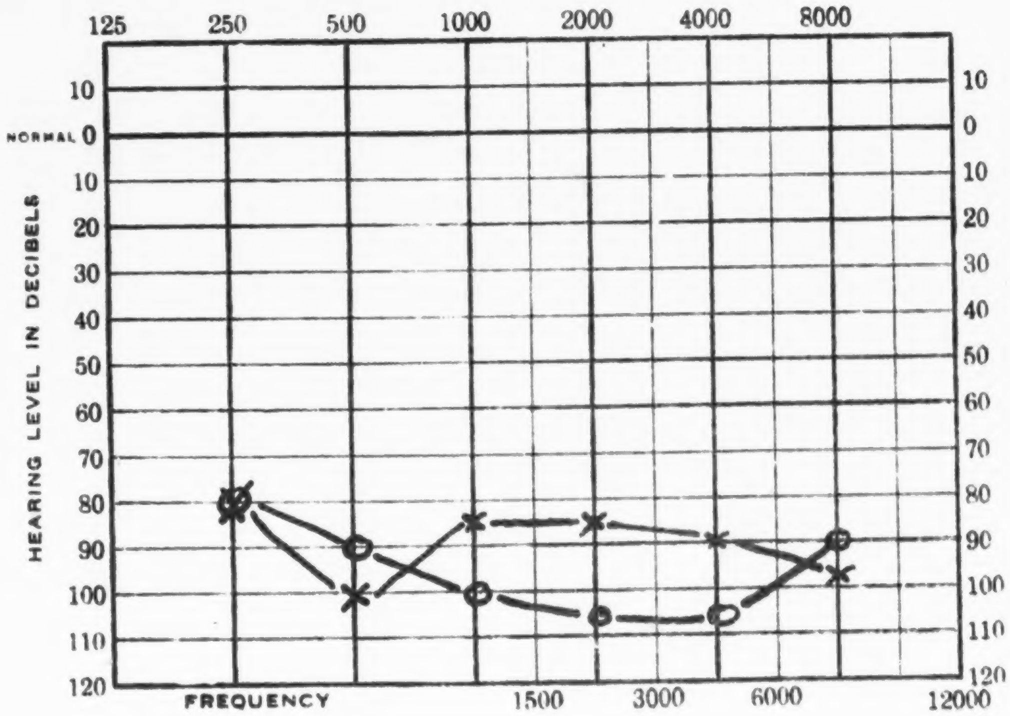
The following changes were observed in Gail's speech during the experimental period: greater, more frequent differentiation between [m] and [b], more frequent smooth transitions from [m] in initial position, increase in frictional component in [f] and [s], increase in both frictional and vocal components in [v] and [z], drastic reduction of omissions of [f] [s] [v] and [z] and some reduction of omissions of plosive sounds, increase in nasal resonance in [n] and friction in [θ], reduction of distortion of [l], and addition of voice to distorted [r]. Though much time was spent with Gail in an attempt to shorten her vocalizations, her speech rhythm was little changed and remained audibly distorted. Individual sounds, particularly [f] [v] [s] and [z] appeared greatly improved in sessions with the Visualizer.

Harvey Consonant Group C.A. 8-3

Family and Environment

Harvey lives with his parents and two sisters in a neat, nicely furnished apartment on an airforce base; Harvey's father, a career serviceman, is a skilled laborer in the air force. The family has been transferred twice in the last five years - from Denver, Colorado to Maine, in 1962, and from Maine to Massachusetts in 1965. From 1962 to 1965, Harvey was compelled to board at a school 300 miles from home and frequently was away for months at a time. Since 1965, Harvey has boarded at a school which is close enough to allow him to be home every weekend. Harvey's father is to retire in 3 1/2 years, a change which will bring the family welcomed mobility and the opportunity to settle near a school for the deaf. Harvey's older sister, 12, has normal hearing; his younger sister, 4 years old, has a moderate hearing loss.

Audiogram



History of Deafness

Harvey's deafness has been attributed to premature birth, after a pregnancy of 7 months. He required oxygen at birth and incubation for two months following. Deafness was discovered at 1 1/2 years.

Response to Environmental Auditory Stimuli

Harvey responds to very loud sounds only.

Health and Physical Status

Harvey's development has progressed normally. He has been hospitalized twice, once at four months for a hernia operation and again at six years for a tonsillectomy and adenoidectomy. He is in good health, though somewhat slight for his age.

Visual Perception

He scored low on both the Ayres and the Frostig; his z scores on the two tests were 17 and 2 respectively. His combined group rank was 22.

Intellectual Functioning

It is the impression of Harvey's teacher that Harvey is functioning below average intellectually. On the WISC Performance Scale, he received an IQ of 83. However, it should be noted that Harvey did not test well; his attention was poor during administration of the test and his score should be considered as an indication of his functioning at that time, rather than as an indication of his overall level of intellectual functioning.

Education

After his deafness was discovered at 18 months, Harvey was enrolled in nursery school for two mornings a week. His mother also attempted to teach him by using the John Tracy Correspondence course, but found Harvey unable to attend the instruction. At the age of 3 1/2, he was transferred to a school in Denver where he attended a class for the deaf daily. When his family moved to Maine, Harvey was enrolled in a school for the deaf there, where he was taught primarily manually for three years.
He now attends and boards at a totally oral school for the deaf, where, in the middle of this year, he was transferred from grade 1B to a class for children with learning disabilities. His present teacher employs an elements approach in the teaching of speech, in combination with the McGinnis method of teaching language.

Communicative Behavior - parent's report

According to the mother, Harvey communicates primarily through gestures and though he rarely uses his voice except to gain attention at home, he seems to be relying less on signs since his transfer to a totally oral school. He has one word which is intelligible to his mother -- "home."

Communicative Behavior - teacher's report

Harvey's teacher reports that he is functioning below average receptively and expressively in verbal language functioning.

Psycho-Social Behavior - parent's report

According to his mother, Harvey "makes friends easily," and likes to play with boys somewhat older than he. He has no difficulty communicating (in gestures) with his neighborhood friends and joins happily in all outdoor games. Harvey's mother reports that he likes all sorts of physical exercise but has very little tolerance for sitting still and paying attention. She reports also that he is prone to daydreaming.

Psycho-Social Behavior - teacher's report

It was the impression of Harvey's teacher that, with respect to her present class, Harvey could be rated as one of the two pupils with the best mental health.

Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Harvey's voice was strained and weak and, in words, all his phonemes were distorted or omitted. Of the experimental sounds, there were substitutions of [b/m], [ft/f] [ft/v] [dθ/θ], omissions of [s] [z] [n] and [l] and distortion of [r].

Observations of Behavior during Sessions

During sessions with the Visualizer, Harvey was restless and appeared to be bored and frustrated by his inability to adjust his patterns more closely to the standard and to adjust his speech rhythm more nearly to a standard rate. As he was taught in school by an elements approach, his individual phonemes were prolonged to a greater degree than most of the other children in the study and his speech was considerably more distorted by his tendency to segment words into individual phonemes. Having transferred from a manually oriented school only last year, his reading and lip-reading vocabulary was extremely limited and many words in the materials were unfamiliar to him. His attention to the Visualizer screen was poor, and even when watching, he rarely appeared to be monitoring his speech.

Observations of Changes in Harvey's Speech

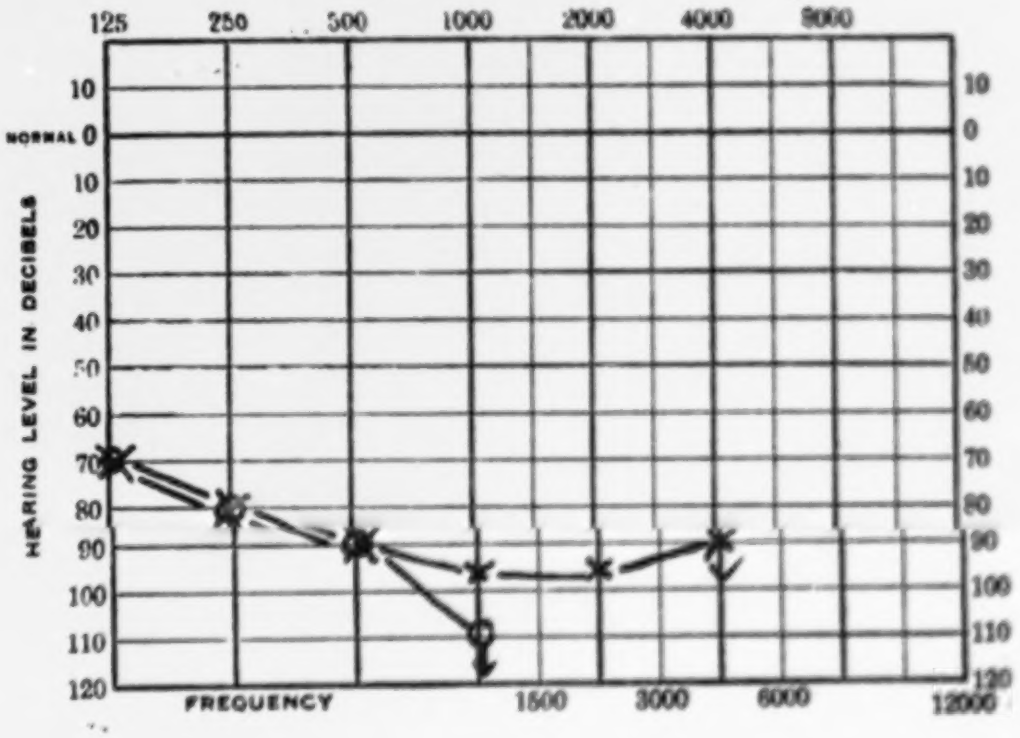
The following changes were observed in Harvey's speech: increase in duration of frictional component and decrease of plosive quality in [f], decrease of [b/m] substitution in words beginning with [m], reduction of plosive quality in [θ], reduction of distortion in [n], and substantial reduction of omissions of an [s] approximation. There were some changes in Harvey's speech which were not maintained throughout the experimental period: addition of standard amounts of friction and voice in [v], and addition of some friction and voice in [z]. Frames containing [r] and [l] were not reached by the end of the experimental period. Harvey appeared to strain somewhat less when vocalizing, as the experimental period progressed, but there was little change in his established pattern of abnormally prolonging all phonemes in words.

Iris Consonant Group C.A. 8-8

Family and Environment

Iris lives with her mother and 13 year old hearing sister in a large and modern house situated in a small suburban community. Her parents were divorced two years ago. Iris' mother works during school hours as a cafeteria assistant. Iris boards at the school for the deaf during the week, and spends weekends and vacations at home.

Audiogram



History of Deafness

The cause of Iris' deafness is thought to be the result of either blood type incompatibility (her mother is Rh negative) or third degree burns which she received shortly after birth. Her loss of hearing was noticed when she was about one year old.

Response to Environmental Auditory Stimuli

According to her mother, Iris responds inconsistently to environmental sounds. At times, she responds to the door bell or to her mother's voice; at other times, she does not respond to even very loud noises. In school, Iris is able to discriminate words and phrases auditorily.

Health and Physical Status

Labor was induced after eight months of pregnancy because of the problem of Rh incompatibility. Delivery was normal, but the child was jaundiced at birth, and subsequently had five blood exchanges. According to her mother, Iris suffered third degree burns on her buttocks during and in connection with the second blood exchange. She required incubation for one day after birth, and remained in the hospital for a month. Iris sat up alone at six months and walked alone at about two years. Outside of her difficulties at birth and her somewhat late start in walking, her development has been normal. However, she does appear to be rather uncoordinated, has an awkward gait and generally exibits the spasmodic movements of a somewhat cerebrally palsied child. Iris is in good health.

Visual Perception

Iris scored quite low on both the Ayres and the Frostig. Her z scores on the two tests were 7 and 0 respectively. She placed lowest - 24 - in the combined group rank.

Intellectual Functioning

At age 7-3, Iris was given the performance items on the WISC. Her score on the Performance Scale indicated an IQ of 101. Reports from the school Iris previously attended showed adequate academic performance, but reports from her present school indicate that she is falling below average academically. The impression of her present teacher is that she is functioning below average intellectually, with respect to functioning of deaf children at her class level, and that quite often she has difficulty learning.

Education

Iris was educated for four years, from age 3-7, at a boarding school for the deaf in New York state. She entered the school for the deaf which she presently attends at age 7-5, and now in her second year there, she is repeating grade 2.

Communicative Behavior - parent's report

At home, Iris communicates in one or two word phrases which are often unintelligible to her mother. When her speech is not understood, she often writes out or draws a picture of what she is intending to express.

Communicative Behavior - teacher's report

According to her teacher, Iris is functioning below average in lipreading, reading, writing, and speaking, relative to functioning of deaf children at her class level.

Psycho-Social Behavior - parent's report

Before moving to their present home, her mother reports, Iris did not have friends of her own age, but simply tagged along with her older sister. Now in the present location, there are children of Iris' age but she has been unable to establish a relationship with any of them. According to her mother, Iris likes to tease other children and bothers them with pinching and poking. Iris' aggressive behavior reached a critical point last summer, intiated when a younger cousin was visiting and planning to spend the night. Iris reportedly became suddenly hostile and from that night on during the summer, became increasingly more difficult to manage. She finally reached a stage when her mother began to dread the beginning of each day. On one occasion, Iris brandished a kitchen knife at her mother.

Iris, according to her mother, is fearless. Once, when swimming, she almost drowned, but once having recovered her breath, she jumped back into the water without hesitation.

Psycho-Social Behavior - teacher's report

Iris' teacher rates her as one of the two most emotionally disturbed pupils in her present class. It is her impression that Iris quite often gets into quarrels with other pupils and quite often behaves in ways which are dangerous to herself and others.

Initial Observations of Speech and Voice

Iris' voice quality and inflectional patterns were extremely good. Though her speech was slightly prolonged, overall speech rhythm was good. Initial analysis of her speech indicated that her vowels, though distorted, were generally intelligible. Consonants showed a greater degree of distortion than the vowels. Among the experimental sounds, there were substitutions of [b/m] [w/r] [l/n] [t/s] [d/z] and distortions of [v] and [θ]. [l] and [f] were articulated correctly.

Observations of Behavior during Sessions

In sessions with the research teacher, Iris demonstrated that she had at her command a natural rhythmic flow of spoken language. While her ability to understand verbal language was relatively very good, she appeared to have considerably more difficulty comprehending written language than spoken language and revealed occasional perceptual reversals of phonemes in both reading and lipreading. She was outgoing and talkative and, at times, aggressive. Frequently hyperactive, she often found it difficult to attend to the task of monitoring her speech. However, she was generally cooperative and attentive to the task of visual monitoring when she was relaxed and/or when she was handled with firm but gentle direction.

Observations of Changes in Iris' Speech

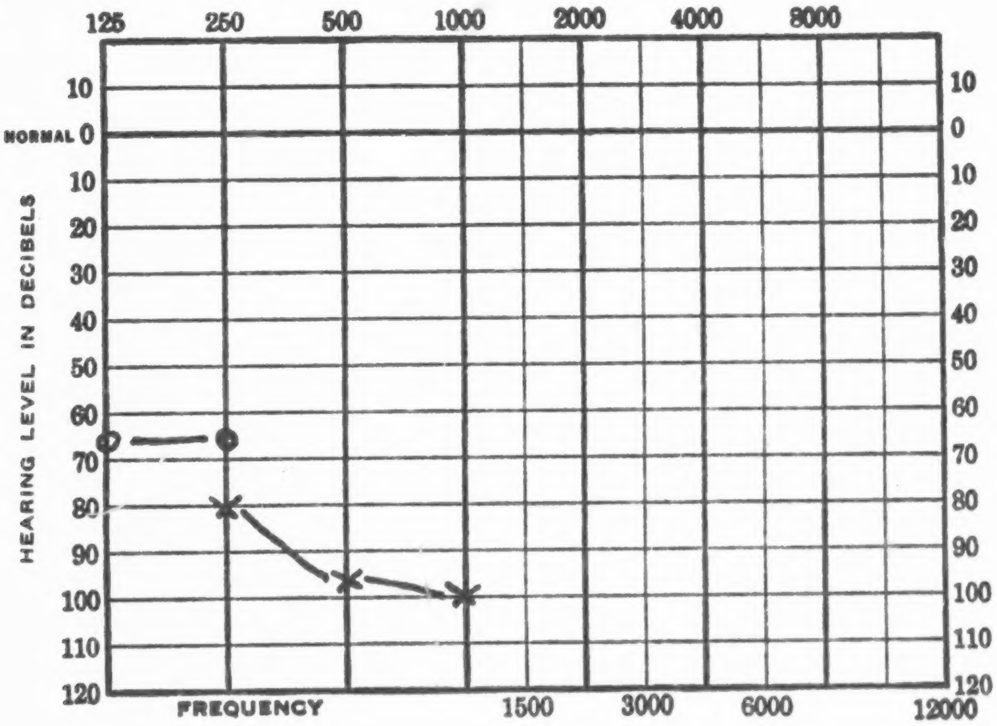
The following changes were observed in Iris' speech: substantial reduction of [s] - [t] confusion and [s] omissions, addition of frictional component in [z], reduction of [b/m] substitution and increase of smooth transitions from [m] in initial position. Reductions of distortions of [θ] [v] and [n] were observed but not maintained.

Joan Consonant Group C.A. 9-4

Family and Environment

Joan is the oldest of four children, three of whom are deaf. Along with her two deaf siblings, Joan boards at the school for the deaf during the week but travels to her home every week end. In addition to her parents and siblings, Joan's paternal grandfather lives in the home. Her father is a salesman.

Audiogram



History of Deafness

Joan was apparently born deaf. Etiology is unknown. Her hearing loss was first suspected when she was about one year old.

Health and Physical Status

Outside of the usual childhood diseases, Joan has been in good health. She is rather obese and has been, her mother reports, since she entered school.

Visual Perception

Joan's scores on the Ayres and Frostig tests of visual perception were 86 and 22, respectively. Her combined group rank was 4.

Intellectual Functioning

Scores on intelligence tests administered when Joan was 6 1/2 years, along with school records from that time, suggest that as a pre-schooler, she was potentially able to function above average intellectually, but did not perform up to her capabilities.

Pre-School Battery	Goodenough-Draw-a-Man	Gesell Drawing Test
C.A. 6-10	C.A. 6-10	C.A. 6-10
M.A. 8-10	M.A. 8-10	I.Q. 116
	I.Q. 117	

WISC Performance Scale only	
C.A. 6-5	C.A. 6-1 -- C.A. 6-10
I.Q. 97	Average in academic work—D

In her subsequent years in school, Joan's performance has gradually improved. It is the impression of her present teacher that she is functioning on an average level intellectually.

Education

When she was 2 1/2 years old, Joan received speech therapy a half hour weekly for an approximate two-year accumulated period, at a local rehabilitation center. In addition, Joan's mother worked with her at home with the John Tracy Correspondence Course. Joan was enrolled for one year at a residential school for the deaf before transferring to the school which she presently attends. When the transfer was made, Joan's younger sister was enrolled in the school with her. Now in her fifth year in a school for the deaf, Joan is in grade 3.

Communicative Behavior - parent's report

Joan uses a combination of speech and gestures, supplemented by writing as a last resort, for communicating at home. Her mother reports that Joan is reluctant to speak slowly and articulate her sounds carefully.

Communicative Behavior - teacher's report

It is the impression of Joan's teacher that she is functioning on an average level in lipreading, reading, speaking and writing, both in words and in sentences.

Psycho-Social Behavior - parent's report

Joan shows interest in activities typical for a girl of her age, but spends most of her time at home on week ends "laying around and watching T.V." When it is suggested that she go outside and play, Joan explains that she is "tired from working so hard at school."Lately, Joan has complained of stomach aches and has frequently expressed a desire to live at home. Her mother feels that both the stomach aches and her expression of a desire to live at home are indications that Joan is "anxious about growing up."

Psycho-Social Behavior - teacher's report

Joan's teacher reports that she shows no maladjustive behavior in school. Her relationships with peers and teachers appear to be normal.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Joan's speech quality and speech rhythm were severely distorted, and most of her phonemes were distorted in words. Present in her speech were distortions of [r] and [θ], substitutions of [b/m] [v/f] [b/v], confusions of [s]-[t], and [n]-[l], and omission of [z].

Observations of Behavior during Sessions

Joan was generally very cooperative and usually quite successful in monitoring her speech visually. She usually watched the Visualizer closely and seemed fully aware of what her task was and how to accomplish it.

Observations of Changes in Joan's Speech

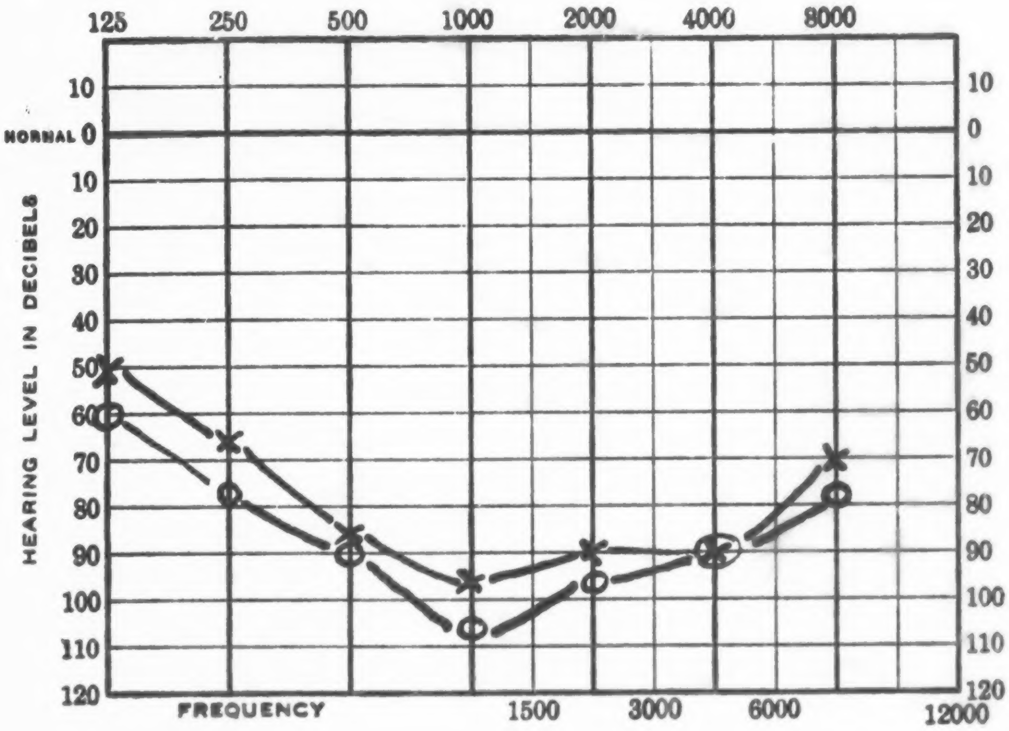
The following changes were observed in Joan's speech during the experimental period: substantial reduction of [s] - [t] confusion and omissions of [s] in words, substantial reduction of distortions of [m] and [v], increase in frictional and voiced components of [z] with reduction of omissions of [z], slight reduction of distortions in [r] and [θ], slight reduction in amount of [n] - [l] confusion, and reduction of omissions of final plosives and final fricative continuants.

Kay Consonant Group C.A. 9-5

Family and Environment

Kay lives with her mother and younger brother in a small community about 20 miles from Boston. Kay's parents are separated. She boards at school during the week. She is the only member of the family who is deaf.

Audiogram



History of Deafness

The case of Kay's deafness has not been determined. Loss of hearing was first suspected when she was 2 1/2 years old by her nursery school teacher.

Response to Environmental Auditory Stimuli

Kay's teacher reports that Kay responds to loud sounds but that her ability to discriminate gross sounds is inconsistent. Her mother also reports that her response to sound is inconsistent.

Health and Physical Status

Kay is in sound physical condition.

Visual Perception

Her z scores on the Ayres and the Frostig were 74 and 3 respectively. Her combined group rank was 16.

Intellectual Functioning

Scores on tests administered when Kay was almost 7 years old along with her present teacher's impression indicate that she has been functioning within normal limits intellectually.

Pre-School Battery		Gesell Drawing Test		Goodenough-Draw-a-Man	
C.A.	6-11	C.A.	6-10	C.A.	6-11
M.A.	6-6	M.A.	6-6	M.A.	6-6
		I.Q.	95	I.Q.	94

Her performance in school shows average to good performance.

Education

Kay attended nursery and pre-school classes at two different schools for the deaf. She entered a third school for the deaf at C.A. 6-2 and is now there in grade 3.

Communicative Behavior - parent's report

At home, she speaks in short phrases often supplemented by gestures. She watches lips and is able to lipread much of what is said to her.

Communicative Behavior - teacher's report

According to her teacher, Kay is functioning on an average level in most aspects of receptive verbal language but is below average in lipreading sentences and reading vocabulary.

Psycho-Social behavior - parent's and teacher's report

Kay enjoys activities typical for her age. Both her mother and her teacher report no unusual behavior and no difficulty in relating to other people.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Kay's voice, while often natural in voice quality, tone and inflection, was occasionally high pitched and weak. Observed in her speech were a number of vowel and consonant distortions including distortions of [n] and [f], substitutions of [w/r] [ts/s] [ts/z] [t/θ] and confusions of [m] - [b] and [n] - [l].

Observations of Behavior during Sessions

Kay grasped the task of visual monitoring and moved quickly through the sequence of frames. She was extremely interested in the machine and cooperative in the beginning but after the first month of the experimental period, she appeared to lose interest and seemed somewhat annoyed at having to correct her speech and attend to the Visualizer patterns. The sessions with her shortened to 10-15 minutes in length and, towards the end of the experimental period, to 5 minutes in length. Even in these short sessions, she was able to progress through the frames at a normal rate.

Observations of Changes in Kay's Speech

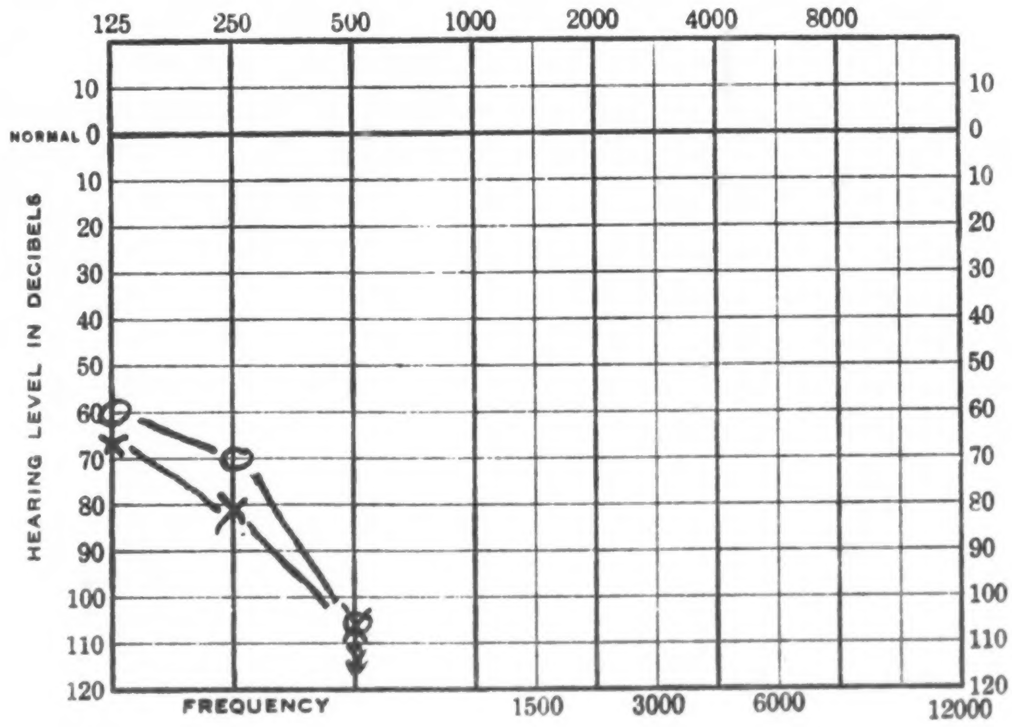
The following changes were observed in Kay's speech: increase of frictional component of [f] and [θ], decrease in confusion between [t] and [s], and between [m] and [b], increase of voice in [z], decrease in omissions of unvoiced plosives particularly in final position. No change was apparent in [l] or [r] patterns, and no decrease in the confusion between [l] and [n] was observed. At the beginning of the experimental period, by practicing words containing the vowel [ʌ], which she spoke naturally at a normal pitch level, she was able to control her pitch level on all words. However, after the first two months of the experimental period she reverted to her previous pitch level.

Larry Consonant Group C.A. 9-8

Family and Environment

Larry has three normally hearing siblings, an older and a younger brother and one small sister. The family lives in an old, remodeled house in a wooded residential area. Larry's father teaches at a scientific institute.

Audiogram



History of Deafness

Larry was born with normal hearing and developed speech normally until the age of 22 months when he contracted spinal meningitis. The disease left him profoundly deaf and affected his balance.

Response to Auditory Stimuli

According to his teacher, Larry responds to loud sounds, and can discriminate auditorily, gross sounds, a few words, and a few phrases.

Health and Physical Status

Following spinal meningitis, it was necessary for Larry to relearn how to sit up, to stand and to walk; at the end of a period of six months, he was able to walk alone again, although stiff-legged. Larry's gait is still awkward and his balance unsteady. He has been unable to learn to swim because of his loss of spatial orientation when his vision is blurred or obstructed.

Visual Perception

Larry's z scores on the Ayres and the Frostig were 82 and 10 respectively. His combined group rank was 11.

Intellectual Functioning

Scores in Larry's school folder indicate that, at pre-school age, he was functioning far above average intellectually.

WISC Performance Scale	Gesell Drawing Test	Goodenough-Draw-a-Man
C.A. 6-7	C.A. 5-7	C.A. 5-7
I.Q. 140	M.A. 7+	M.A. 8-6
		I.Q. 152

His school record suggests average and above average performance academically; his present teacher feels that he is functioning on an average level intellectually.

Larry was tutored for about a year from the age of 2 1/2 to 3 1/2 at a league for the hard of hearing. He spent three months subsequently, in a nursery class for the deaf and following that, a year in a regular nursery program. At C.A. 4-1, he was enrolled in a school for the deaf where, now in his sixth year there, he is in grade 3.

Communicative Behavior - parent's report

Larry's parents are eager for him to develop proficiency in reading and verbal communication. At the present time, he communicates by speaking and lipreading supplemented by gestures when needed. He borrows books from the public library on the encouragement of his parents, but does little more than look at the pictures. He has no difficulty however understanding printed directions accompanying model car and oregami kits, and he apparently enjoys very much meeting the challenge of this type of reading.

Communicative Behavior - teacher's report

According to his teacher, Larry is functioning on an average level in all verbal communication skills.

Psycho-Social Behavior - parent's report

For a period of about one year after Larry's illness at 22 months, he withdrew from other people and, when with a group of children, often cried silently by himself. When he was about three years old, he began to find an outlet in working with his hands, an interest which had manifested itself before his illness and which has continued to the present time. Larry gets along well with his two brothers and dotes on his little sister. He enjoys playing with his brothers' friends but is beginning to realize and accept that he cannot participate in all the activities which his brothers initiate because of his hearing loss and his deficient sense of balance. His mother reports that he is a "determined," at times "stubborn" child; when he sets about to do something, he persists until the task is completed.

Psycho-Social Behavior - teacher's report

It is the teacher's impression that Larry exibits no maladjustive behavior in school. He works diligently, particularly on his speech.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Larry's voice was monotonous and flat and his speech was prolonged to a considerable degree. Most of his vowels and many of his consonants were distorted. Consonant distortions included [f] and [v],substitutions of [b/m] [n/l] [w/r] [d/z] [dt/θ], prolongation of final continuants or addition of [ʌ] after final consonants, increase in pressure behind, and omission of aspiration from, voiceless plosives [p] and [t].

Observations of Behavior during Sessions

Larry was extremely cooperative and attentive during sessions with the Visualizer. He had been introduced to the machine several years prior to this study and remembered spontaneously many of the patterns and how to use them for visual monitoring. He generally watched the screen but often had to be reminded to attend to the monitored pattern and what it indicated. About one-half way through the experimental period, he seemed to lose interest and although he appeared to be trying to cooperate, his attention to visual monitoring decreased.

Observations of Changes in Larry's Speech

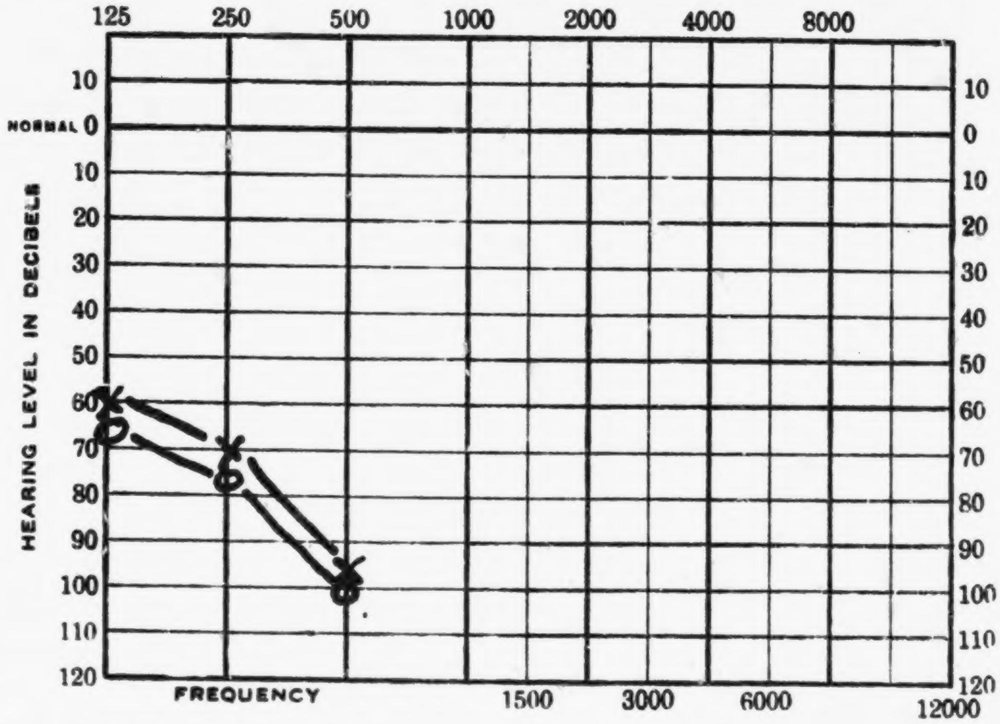
The following changes were observed in Larry's speech during the experimental period: reduction of distortions in [r] and [θ], decrease of nasality in [l], increase of voice and friction in [z] and [v], increase of duration of [f], reduction in additions of [ʌ] after final consonants, decrease in excessive pressure behind [p] and [t] in initial position, and spontaneous correction of [i] with re-introduction of [i] pattern.

Melissa Vowel Group C.A. 7-2

Family and Environment

Melissa is the youngest of four girls and the only member of her family who is deaf. She lives with her parents and sisters in a large, comfortable house located in a small town outside of Boston. Her father works as a purchasing agent.

Audiogram



History of Deafness

Melissa was apparently born deaf. Though her mother is Rh-, it is reported that Melissa's blood was not exchanged after her birth. The pregnancy and delivery were normal, and the child had no complications after birth. When Melissa was almost two years old, her parents became concerned that she was not speaking and placed her in the hospital for a two day diagnostic work-up. Deafness was strongly suspected at that time and later confirmed.

Response to Environmental Auditory Stimuli

Melissa's teacher reports that she is able to discriminate gross sounds.

Health and Physical Status

Melissa has had no major illnesses and is in sound physical condition.

Visual Perception

Her z scores on the Ayres and the Frostig were 77 and 45 respectively. Her combined group rank on the two tests was 3.

Intellectual Functioning

Results of tests administered at the end of Melissa's first year in school indicate that at that time she was potentially able to function considerably above average intellectually.

Pre-School Battery	Gesell Drawing Test	Goodenough-Draw-a-Man
C.A. 4-5	C.A. 4-5	C.A. 4-5
M.A. 5-5	M.A. 5-6	M.A. 5-6
	I.Q. 122	I.Q. 124

Her school record indicates average performance, but it is the impression of her present teacher that she is functioning below average intellectually and that she frequently has difficulty learning.

Education

For a period of time within the year and one-half prior to her entrance into the school for the deaf at C.A. 3-11, Melissa was given speech and language training through the state nursery program for the deaf. Now in her fourth year in school, she is in grade 1A.

Communicative Behavior - parent's report

Her mother reports that Melissa communicates at home by gesture and some speech. The research teacher, having the opportunity to see Melissa with her sisters, observed that she communicated primarily by gesture, though she used her voice frequently in addition, for exclamations and single words.

Communicative Behavior - teacher's report

It is the impression of Melissa's teacher, that she is functioning below average in all aspects of verbal language, written and spoken.

Psycho-Social Behavior - parent's report

Her mother reports that Melissa shows no unusual behavior at home, and that she engages in activities typical for a girl of her age.

Psycho-Social Behavior - teacher's report

According to her teacher, Melissa exibits no maladjustive behavior in school. She is occasionaly shy with adults but has no apparent difficulties in her relationships with her peers.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observation of Speech and Voice

Melissa's voice was high-pitched and taut. In the initial speech analysis of phonemes spoken in words, all of her speech sounds, vowels and consonants without exception, were distorted or omitted.

Observations of Behavior during Sessions

Melissa was generally cooperative but often found it difficult to concentrate upon keeping her pitch down, shortening the duration of her phonemes and watching for visual clues from the Visualizer at once. It was necessary for the research teacher to remind Melissa continually to watch and attend to the Visualizer patterns.

Observations of Changes in Melissa's Speech

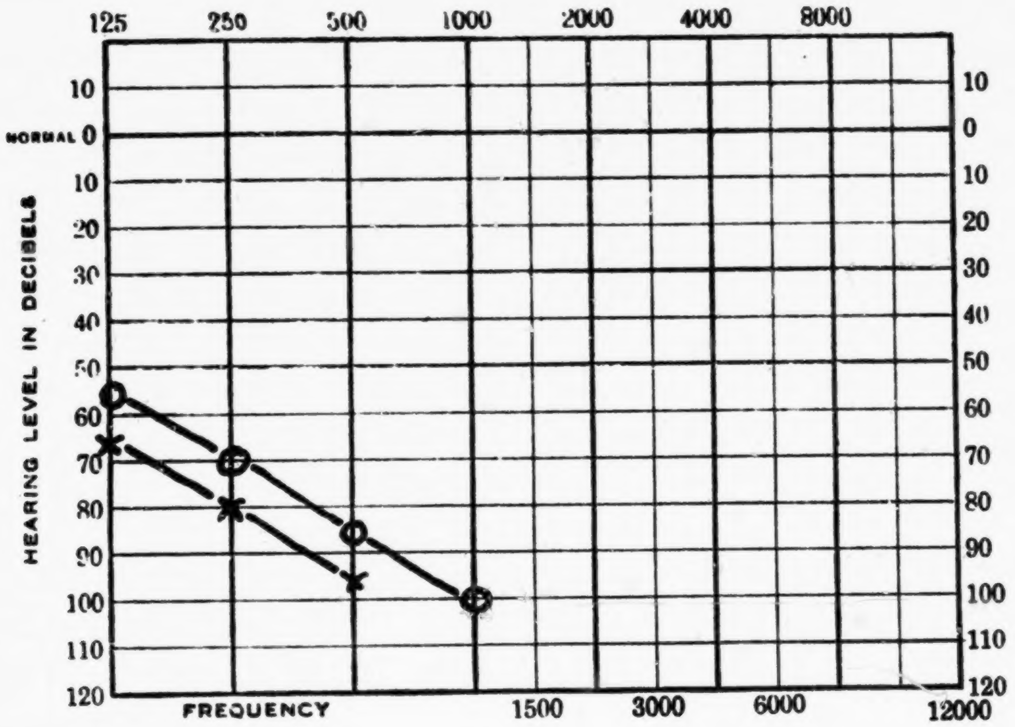
The following changes were observed in Melissa's speech during the experimental period: considerable reduction of distortion of [ɑ] accompanied by lowered pitch, considerable reduction of distortion of [i] but inconsistent from session to session. Reduction of distortions of [o], and [u] were observed at one point but not maintained. No change was apparent in [ɛ] [æ] or [ɔ]. Melissa was often able to monitor her pitch by phonating [u] and watching the [u] pattern take form as she brought her pitch level down.

Nancy Vowel Group C.A. 7-2

Family and Environment

This family, including parents, infant sister, aunt, and grandmother, lives in one-half of a two family house in a middle income, residential neighborhood.

Audiogram



History of Deafness

Nancy was apparently born without hearing. Her deafness has no known etiology.

Response to Environmental Auditory Stimuli

Both at home and at school, Nancy is able to discriminate gross sounds. Her mother reports that in the past, Nancy was frightened by loud noises, but now that she is able to identify them, and knowing what they mean, she is no longer afraid.

Health and Physical Status

Nancy's physical development has progressed normally. Other than hospitalization for viral infection, and some problem with allergies, she has been in good health.

Visual Perception

Nancy's scores on the Ayres and the Frostig were 87 and 46 respectively. Her combined group rank on the two tests was 2.

Intellectual Functioning

It is the impression of her teacher that Nancy is functioning on an average level intellectually. Score recorded in her school folder indicates above average ability.

Goodenough Draw-a-Man

C.A.	6-9
M.A.	8-0
I.Q.	118

Education

Nancy attended a nursery program at a school for the deaf for 3 years, beginning at the age of 2. At 5, she entered the school for the deaf which she presently attends and where she has been promoted regularly. She is now in grade 1A.

Communicative Behavior - parent's report

Her mother reports that Nancy "talks a lot" at home, and is usually understood. She speaks in one word phrases generally, though she is beginning to use some longer phrases. If Nancy cannot make herself understood, she writes.

Communicative Behavior - teacher's report

According to her teacher, she is functioning on an average level in verbal language, both expressively and receptively.

Psycho-Social Behavior - parent's report

Nancy's mother reports that Nancy "likes to get her own way." Though Nancy finds it difficult to accept a "no", she is appeased if time is taken to explain the reason for the negative response and if some other enjoyable activity is substituted in its place.

Nancy has not been accepted in her neighborhood, by her peers or by their parents. According to her mother, Nancy tends to be aggressive ; "she likes to be the leader in any project." Many of the neighborhood children taunt and mimic her, while some of the parents have asked that she be kept away from their children. Apparently, a few of the children exploit Nancy by playing upon her "generosity," (or, more probably, her desire to be accepted), enticing her into giving them her toys and other belongings. She does have one friend in the neighborhood, a nine year old hearing girl with whom she often plays. After a period of adjustment following the birth of a sibling, Nancy now seems to accept and enjoy her new sister.

Clinical Report of Speech and Behavior Patterns

Initial Observation of Speech and Voice

Nancy's voice was extremely low in pitch, monotonous and distorted. Phonemes were prolonged to a considerable degree and most were unintelligible in words. Present were distortions of [ɛ] [u] [i] [ɑ] [ɔ] and [æ] and a substitution of [oʌ/o]. Vowel distortions were numerous, not because vowels were necessarily poorly formed, but most often because her voice quality was so distorted.

Observations of Behavior during Sessions

Nancy was restless and highly distractible during most sessions. Her attention to the Visualizer and to the materials was poor, and rapport with the research teacher was never firmly established. Her behavior was often bizarre, taking the form of making jokes aside to herself and vocalizing and gesturing grandiosely as if explaining (to no one in particular) an unknown, but absolutely definite point. Her movements were sudden and jerky, and her speech was often accompanied by a tilting motion of the head from side to side. She tended to jab the research teacher quite forcefully when her attention was wanted. Nancy smiled much of the time, often, seemingly, without the association of a happy feeling. She enjoyed watching the screen patterns at times but seemed to have been frustrated by the task of monitoring and understandably so, since her patterns, except for the [u], were generally far from the standard, even after change occurred. She spoke in one or two phrases, even the most common of which were unintelligible, but generally was able to make herself understood by supplementing her speech with gesturing or writing.

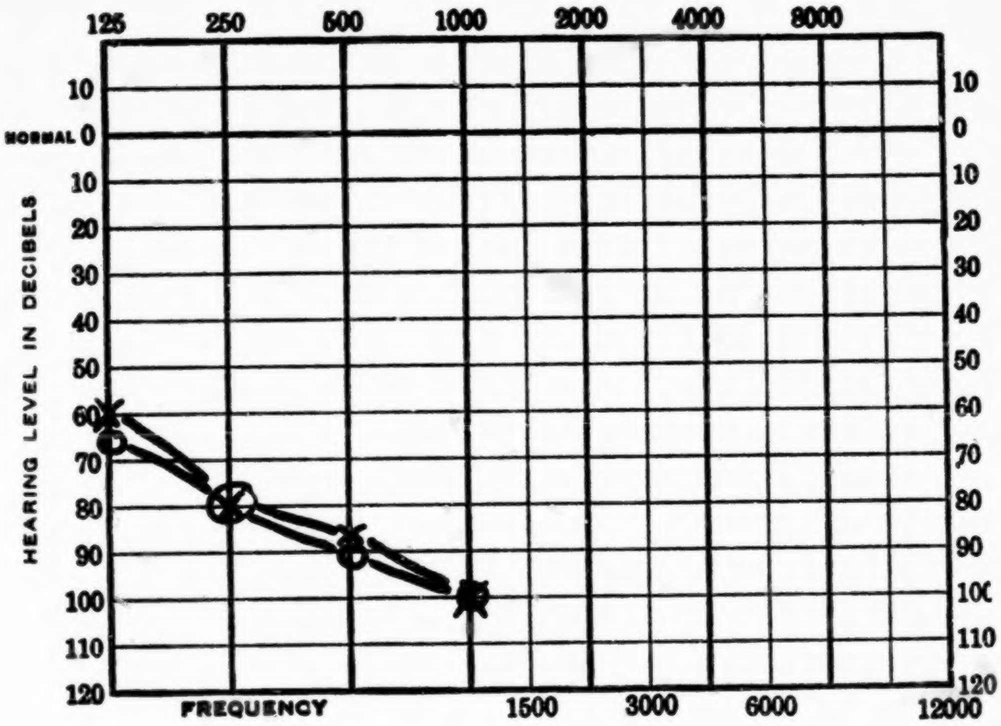
Observations of Changes in Nancy's Speech

Reductions of distortions of [o] and [ɑ] [ɔ] and [æ]were observed in Nancy' speech during the experimental period. At one point, considerable reduction of distortion in [u] was observed but this change was not maintained. No change was apparent in either the [i] or [ɛ] patterns.

Otto   Vowel Group   C.A. 7-8

Family and Environment

Otto is the middle of three children. His sister, one year older than he, has normal hearing; his brother, four years younger, is also deaf. Otto's mother is trained as a medical secretary but does not work now. His father is a ramp serviceman for an airline. Otto boarded at school during the week for several months last fall but was apparently quite lonesome away from home and it was decided that boarding be discontinued. The family lives in a quite, wooded street in a suburban residential area.



History of Deafness

Otto's deafness was first thought to be the result of overmedication of the mother during labor and delivery. Labor was induced when the pregnancy had continued three weeks beyond due date. Otto was blue at birth, and was given oxygen and placed in an incubator for 24 hours. During the birth of Otto's deaf brother, however, it was not administered.
It is now suspected that in both cases,

deafness was congenital. Otto's deafness was first noticed when he was 8 months old.

Response to Environmental Auditory Stimuli

Otto only responds to very loud sounds.

Health and Physical Status

He did not sit up alone until the age of 11 months; he walked alone at 16 months. His mother reports that he is still clumsy in walking. Otto was hospitalized twice at the age of 5, once for removal of his tonsils and adenoids, and once for "croup." He has frequent ear aches, stomach aches and colds.

Visual Perception

His z scores on the Ayres and Frostig were 81 and 25 respectively. His combined group rank was 5.

Intellectualy Functioning

Otto was evaluated at a large metropolitan hospital at one year of age, at which time the question of the possibility of mild mental retardation was raised. This impression was based upon his slightly late motor development. Deafness was not diagnosed until several months later. When Otto was 3 1/2 years old, he was evaluated by a psychologist. His performance on formboards and puzzles was very good, as was his performance on items from the Binet; thus, the earlier impression of mental retardation was not substantiated. Scores in his school folder, along with the impression of his present teacher indicate that he has been functioning at an average level intellectually.

Pre-School Battery	Gesell Drawing Test	Goodenough-Draw-a-Man
C.A. 5-1	C.A. 5-1	C.A. 5-1
M.A. 5-6	M.A. 6-0	M.A. 4-9
	I.Q. 110	I.Q. 95

Otto's performance in school has been average. He has been promoted regularly but is now in class for children with learning problems.

Education

Otto was tutored one hour weekly for 2 years from 2 to 4 years of age by a clinical teacher of the deaf. For two months following this, he attended nursery school. At 4 1/2, he entered the school for the deaf, where he is now in grade 1A.

Communicative Behavior - parent's report

Otto had about 20-25 words when he entered school at 4 1/2. He now uses one word phrases which are often unintelligible to his mother. Thus, there is an implication that he has made very little progress in spoken verbal communication. He frequently uses gestures at home.

Communicative Behavior - teacher's report

It is the impression of Billy's teacher that he is functioning on an average level in verbal communication both expressively and receptively.

Psycho-Social Behavior - parent's report and others'

When he was 3 1/2, he was evaluated by a psychologist, to examine aggressive behavior reported by his mother. According to her, Otto was prone to biting and spitting, and no amount of punishment (including hitting with a strap) was useful in abating this behavior. The psychologist found him very quiet and generally lacking in expressiveness - during the testing session he did not vocalize at all. His mother stated however that this behavior was not characteristic.

The impression of Otto's teacher-tutor, after working with him for two years (he was then 4 years old) was that, although cooperative at times, he was subject to drastic changes in mood, at times belligerent, at times, lethargic. Under these conditions, it was difficult to assess his progress academically. He seemed to function best when limits upon his behavior were clearly defined. The family's social worker at that time found that Otto seemed to lack the ability to play and reported that his mother would not allow him or his sister to play outside unless she was present.

Otto's mother presently finds him restless and belligerent at home. He is not accepted by his hearing peers in the neighborhood because of his inclination to "boss them around" but often plays with a 14 year old hearing boy who has befriended him. He loves cars and enjoys making model cars and airplanes. According to his mother, Otto tends to take advantage of his older sister, who dotes on him.

Psycho-Social Behavior - teacher's report

It is the impression of Otto's teacher 1) that he quite often makes unusual or inappropriate responses during normal school activities, 2) that he quite often behaves in ways which are dangerous to himself or others and 3) that he is quite often unhappy or depressed. His teacher also reports that he frequently runs to the janitor and firemen at the school, saying, "Father, father."

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Otto's voice was weak and monotonous in intensity, but pitched at a normal level. Many of his consonant words were omitted or distorted. All of his vowels were distorted, [ɑ] and [ɔ] to a lesser degree than the others.

Observations of Behavior during Sessions

Otto's attention to the Visualizer patterns varied with his degree of success. When there was an apparent similarity between his pattern and the standard, as with [o], his attention was good and he relied less upon the encouragement and reinforcement of the research teacher. However, since his patterns usually bore little obvious relation to the standard ones, his attention to the patterns and to the whole situation was generally not good. His lack of familiarity with many of the words in the materials, too, contributed to his frequent air of detachment from the situation.

Generally, Otto showed little initiative for vocalizing and watching the Visualizer patterns but was quite dependent upon teacher instruction and reinforcement. In his first few sessions with the Visualizer, he indicated anxiety over not succeeding by holding tightly or wringing his hands. As the experimental period progressed, he seemed to become more relaxed and gradually offered spontaneous comments about the pictures in the materials, relating them somehow to events at home. In the last few sessions he related, amidst uncontrollable laughter, that almost every picture suggested some violent act committed by "baby." He revealed no indication of to whom "baby" referred. It was observed that Otto's attention and performance were best during the first few minutes of each session.

Observations of Changes in Otto's Speech

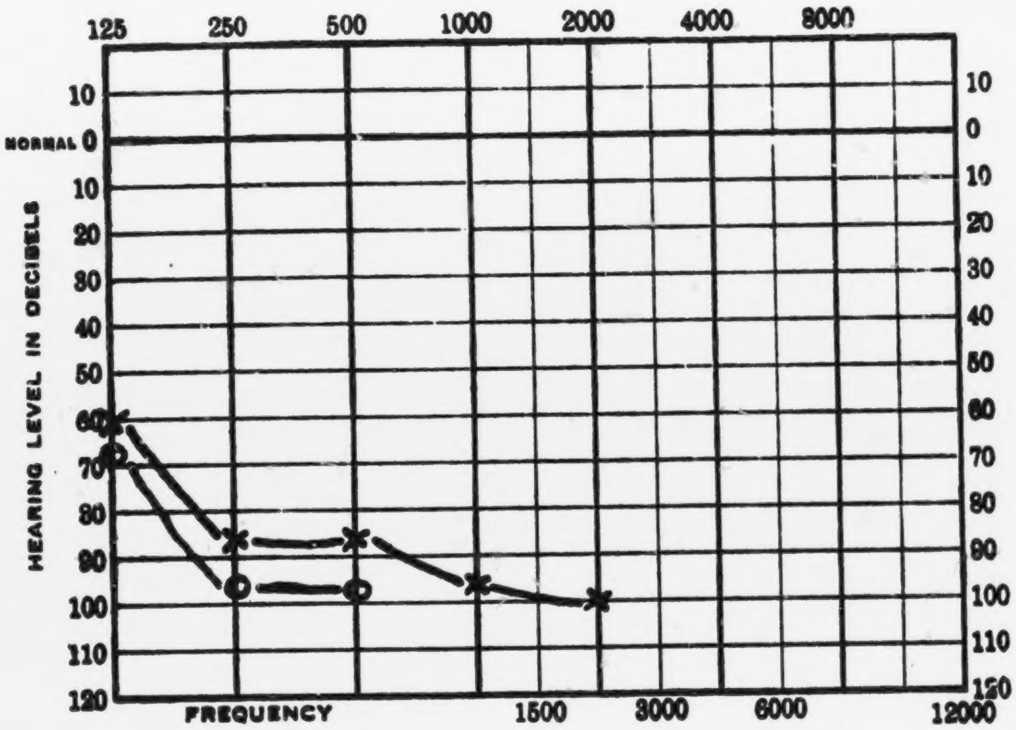
The following changes were observed in Otto's speech during the experimental period: correction of distortion in [o], reduction in the distortion of [ɑ] [u] [æ], decrease in omissions of plosives and fricative continuants [f] and [s]. Reduction of the distortion of [i] was observed but very sporadically. No change was apparent in [ɛ] or [ɔ]. In general, an increase in intensity to a normal level brought about reduction of distortions in vowels, but Otto was reluctant to increase his vocal intensity for other than the [o] sound, perhaps because his degree of success was less with the other vowels even when intensity level was normal.

Pam   Vowel Group   C.A. 7-10

Family and Environment

Pam is the youngest of three girls, and the only member of her family who is deaf. Her father is the owner of a small business. The family lives in a small modern house near Boston.

Audiogram



History of Deafness

Pam was apparently born deaf. Hearing loss was attributed to a virus in her mother during pregnancy. Deafness was first suspected when Pam was about a year old, and she was given a series of hearing tests by several audiologists during the following year.

Response to Environmental Auditory Stimuli

Her teacher reports that Pam is able to discriminate gross sounds.

Health and Physical Status

When Pam was born, several minor abnormalities were evident: low red count, treated with supplemental iron in her diet, "tightened" muscles, treated by rotation, and tear duct malfunctioning, which was not treatable but which she should outgrow as she continues to develop. According to her mother, "the tears don't fall out." As a baby, Pam had many colds and viruses. She has presented a feeding problem both at home and in school.

Visual Perception

Pam's z scores on the Ayres and the Frostig were 13 and 18 respectively. Her combined group rank was 19.5.

Intellectual Functioning

Tests administered when Pam was five years old indicate that she was functioning on an average level intellectually.

Pre-School Battery	Gesell Drawing Test	Goodenough Draw-a-Man
C.A. 5-1	C.A. 5-1	C.A. 5-1
M.A. 5-1	M.A. 5-1	M.A. 5-0
		I.Q. 98

Her record of performance in school has been generally below average, and her present teacher feels that she quite often has difficulty learning.

Education

Pam had several years of pre-school training. Shortly after it was discovered that she was deaf, her mother drove across country with her and enrolled with her in the course at the John Tracy Clinic. Following this experience, Pam and her mother had weekly sessions with a teacher-educator of the deaf. Commenting on both these early training experiences, Pam's mother felt that she gained more from them than Pam herself did. The next year, when Pam was 2-8, she was enrolled in the nursery class at a city school for the deaf, which she attended for two years. It was not until her second year there, her mother feels, that Pam began to profit from training. At C.A. 4-8, she was enrolled in the school for the deaf which she presently attends. Now in her fourth year there, she is in a grade 1A class for children who have difficulty learning.

Communicative Behavior - parent's report

Pam communicates with her sisters and with the children in the neighborhood by gesture. Her mother asks her to imitate and repeat words much of the time, often for example, before satisfying Pam's desire for food. Pam, according to her mother, screams a great deal and babbles to herself, both at home and when out with her mother.

Communicative Behavior - teacher's report

It is the impression of Pam's teacher that Pam is functioning below average in all aspects of verbal communication.

Psycho-Social Behavior - parent's report

As a young child, Pam was extremely active. Her mother found it impossible ever to sleep late because Pam "was into everything." The child liked to sleep with her parents but on the advice of the pediatrician, this practice was discouraged. Even now though, Pam will occasionally awaken in the night and crawl in bed between her parents. Her mother stated that Pam is calming down considerably and is "becoming a young lady," but indicated too that she is still hyperactive and difficult to manage. When Pam comes home from school, she runs around the house jumping on the beds and screaming, and baby sitters will not stay with Pam at night unless she is already asleep.

Psycho-Social Behavior - teacher's report

Pam's teacher feels that, in relation to the other children in her class, she appears to be one of the two most emotionally disturbed children. She quite often presents a feeding problem at lunch and is often hyperactive in the classroom.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Pam's voice was strained and hoarse at times, though generally not monotonous. Pitch was occasionally high, and speech sounds, particularly vowels, were prolonged. About one-half of the consonants were omitted in words and many others were distorted. All of her vowels were distorted, many of them in a way which suggested constriction of the glottal and pharyngeal muscles.

Observations of Behavior during Sessions

Pam was generally active and occasionally restless and giddy during sessions with the Visualizer. She found the changing patterns of the Visualizer fascinating and initiated much vocalization in order to watch the visual results. Though at times she did seem to be monitoring her speech with the Visualizer, she generally did not appear to be motivated to monitor her speech through any medium. Her performance varied with her degree of attentiveness and willingness to cooperate.

Observations of Changes in Pam's Speech

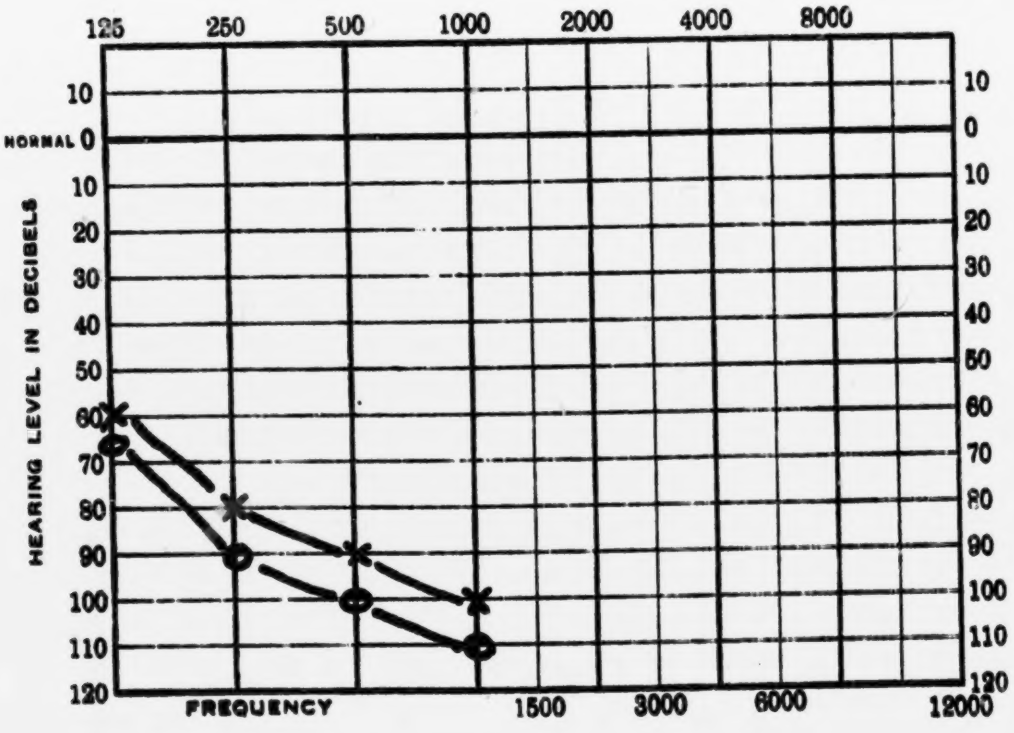
The following changes were observed in Pam's speech: reduction, and occasionally correction of distortions of [a] and [o], reduction of distortions of [u] [i] [æ] and [ɔ], and reduction of occurrence of prolonged vowel duration. In general, a slight increase in vocal intensity produced a decrease in hoarseness.

Quirinal Vowel Group C.A. 8-2

Family and Environment

Quirinal is one of nine children, ranging in age from 2 to 15 years. She has a fraternal twin sister who has normal hearing and is the only member of her family who is deaf. Quirinal's father is a skilled laborer's helper, but has been unable to work for the past seven months because of serious complications following major surgery in April. Quirinal's mother is presently working as a night attendant at a residential school for the mentally retarded in a neighboring town. The family lives in a dilapidated frame house in a city about 50 miles from Boston. Their distance from the school for the deaf requires that Quirinal board at the school during the week, and has contributed to her absences from school beyond those necessitated by illness. The impression received from the mother was that the children have a strong family bond which expresses itself quite forcefully when any one of them, particularly Quirinal, is attacked, verbally or otherwise, by any other child in the neighborhood. And under normal conditions too, "other kids keep an eye" on Quirinal. Her mother feels that Quirinal is catered to somewhat when she is home on the weekends but that a degree of special treatment (getting to watch her favorite T.V. program, having "her own bed") is deserved since she is away from home so much of the time.

Audiogram



History of Deafness

Quirinal and her twin were born prematurely. Quirinal's deafness has been attributed to a nerve injury at birth. She was first given a hearing test when she was 2-8.

Response to Environmental Auditory Clues

Her teacher reports that Quirinal responds to some loud sounds.

Health and Physical Status

Outside of a severe case of pnuemonia and hospitalization for a tonsillectomy, both when she was four years, Quirinal has been in good health and is in sound physical condition.

Visual Acuity

Quirinal wears glasses to correct her vision.

Visual Perception

Results of visual perception testing give highly inconsistent readings of Quirinal's abilities in this area. The Bender-Gestalt, administered in December 1965, indicated generally poor visual motor perception. Quirinal's z scores on the Ayres and the Frostig were 92 and -1 respectively. Her combined group rank on the two tests was 12.

Intellectual Functioning

The results in Quirinal's school folder indicate that she is within the normal range of intellectual functioning.

Pre-School Battery		Gesell Drawing Test		Goodenough-Draw-a-Man	
C.A.	5-7	C.A.	5-7	C.A.	5-7
M.A.	5-6	M.A.	5-4	M.A.	5-6
		I.Q.	95	I.Q.	99

Her school records, however, indicate that she has been functioning below average in academic tasks. Her present teacher supports this view and finds that Quirinal quite often has difficulty learning.

Education

Quirinal had weekly, individual 25-minute sessions in speech and language development for about a year prior to her entrance into the school for the deaf at C.A. 3-11. Now in her fifth year in school, she is in grade IA class for children who have difficulty learning.

Communicative Behavior - parent's report

Her mother reports that Quirinal's primary means of comuication at home is gesture. She does use her voice at times, but "won't use her lips" and just "babbles."

Communicative Behavior - teacher's report

It is the impression of her teacher that Quirinal is functioning below average in all aspects of verbal communication except in the area of lipreading words where she shows an average ability.

Psycho-Social Behavior - parent's report

For her first two years as a weekly boarder at the school for the deaf, Quirinal was unable to leave home without crying. Now, her mother reports, Quirinal seems to be adjusted to the weekly leave-taking, but still will not return to school unless her mother takes the trip with her.

Psycho-Social Behavior - teacher's report

Her teacher reports that she shows no maladjustive behavior in school. She is a playful, lively child, cooperative though not particularly successful in academic tasks.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Quirinal's voice was inclined to be nasal. Initial observation of her speech indicated prolongation of most sounds, distortions or omissions of all consonants and distortions of all vowels.

Observations of Behavior during Sessions

Quirinal was cooperative during sessions with the Visualizer and seemed uninhibited in interaction with the research teacher. When "speaking," she tended to articulate vowel sounds only; her speech was very rarely intelligible and she communicated primarily by gesture and facial expression. When pressed to articulate all sounds in a word, she would articulate a syllable for every phoneme, rendering the word unintelligible.

She enjoyed watching the Visualizer screen and often initiated vocalization on her own. She seemed to understand the concept of matching her pattern to the standard, but showed less comprehension of the process of monitoring changes in her speech. She was quite able to discriminate visually between different patterns and pattern combinations when spoken by the research teacher, but much less able to duplicate those patterns herself. It was apparently difficult for her to make articulatory and acoustic differences between two vowels, when contrasted, though she had demonstrated that she could more closely approximate both vowels when they had appeared in a context without contrast.

Observations of Changes in Quirinal's Speech

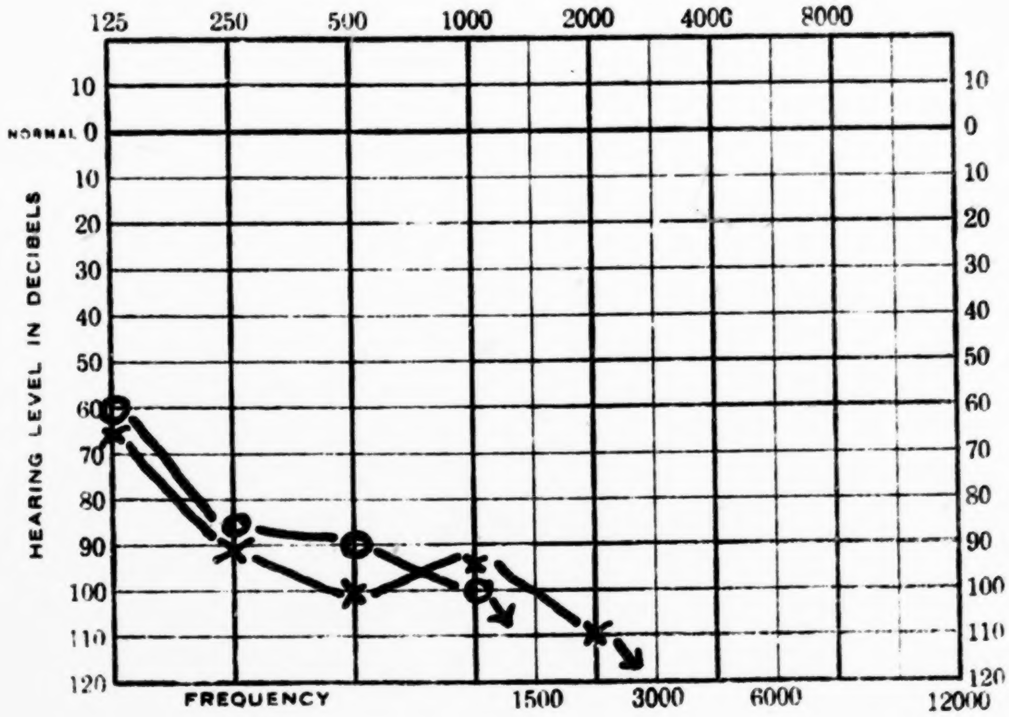
Observed in Quirinal's speech during the experimental period was a reduction of the distortion of [ɑ] [u] [ɛ] and [o]. No change was observed in [ɔ] [æ] or [i]. Decrease in duration of vowels, when attempted, produced decrease in intelligibility. Thus, a substantial decrease in the prolonged duration of vowels was not encouraged or achieved.

Ruth Vowel Group C.A. 8-2

Family and Environment

Ruth lives with foster parents along with two real brothers, both also deaf, aged 14 and 15. Little is known of her natural parents. Her foster mother once visited the natural mother and found her and other of her children to be living in deplorable conditions. Ruth came to live with her present foster parents, both of whom have normal hearing, when she was 2 1/2 years old. Her foster father is employed in the banquet department at a large metropolitan hotel. He works long hours and is often not home in the evenings, but has been able to offer the children financial benefits in travel and clothing. Ruth's foster mother is active as a volunteer in providing transportation for the school for the deaf. She has been greatly concerned lately about the aberrant behavior of the 15 year old boy and his defiance of any control at home. The parents have had over the years more than 50 foster children in their home.

Audiogram



History of Deafness

Ruth's deafness is apparently inherited, though no evidence of deafness in her family is known. Of the seven or more children which her mother produced, three are deaf.

Response to Environmental Auditory Stimuli

She is able to discriminate gross sounds.

Health and Physical Status

At age 2, Ruth reportedly had no tactile sensation. As far as is known, her development has progressed normally since she began living with her foster parents, when she was 2 1/2. From the age of 2 to 3 years, she suffered from chronic tonsillitis, but is now in good health and, other than deafness, has no known physical defects.

Visual Perception

Ruth scored low on both the Ayres and the Frostig. Her z scores on the two tests were 28 and 3 respectively. Her combined group rank was 19.5.

Intellectual Functioning

It is the impression of her teacher that Ruth is functioning on an average level intellectually. Test results recorded in her school folder from an earlier age indicate that she was functioning on an average level or slightly above.

Pre-School Battery		Gesell Drawing Test		Goodenough Draw-a-Man	
C.A.	5-5	C.A.	5-5	C.A.	5-5
M.A.	6-1	M.A.	6-0	M.A.	6-3
		I.Q.	110	I.Q.	115

Education

She entered the school for the deaf at the age of 5. She has been promoted regularly and is now in grade 1A.

Communicative Behavior - parent's report

At home Ruth communicates using a combination of short phrases and gestures. With her brothers, it was observed that she communicated primarily through gestures, though some voice and a few words were used sporadically.

Communicative Behavior - teacher's report

The impression of her present teacher is that Ruth is functioning on an average level in verbal language both expressively and receptively.

Psycho-Social behavior - parent's report

Ruth gets along well in the home particularly with her brother who is closer in age.

Psycho-Social Behavior - teacher's report

Her teacher reports that Ruth shows no unusual behavior in school. She is an outgoing child, and generally appears cheerful and lively.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Ruth's voice was inclined to be nasal. Though she generally maintained a normal pitch level, her voice occasionally became weak and high-pitched. Her speech was prolonged and most of her phonemes were distorted, including all of her vowels.

Observations of Behavior during Sessions

Ruth was lively and cooperative during sessions with the Visualizer. Her attention to her speech was generally good, though interest in and monitoring with the Visualizer seemed to slacken about one-half way through the experimental period. She initiated much conversation, and her speech, when supplemented by occasional gestures, was generally intelligible to the research teacher.

Observations of Changes in Ruth's Speech

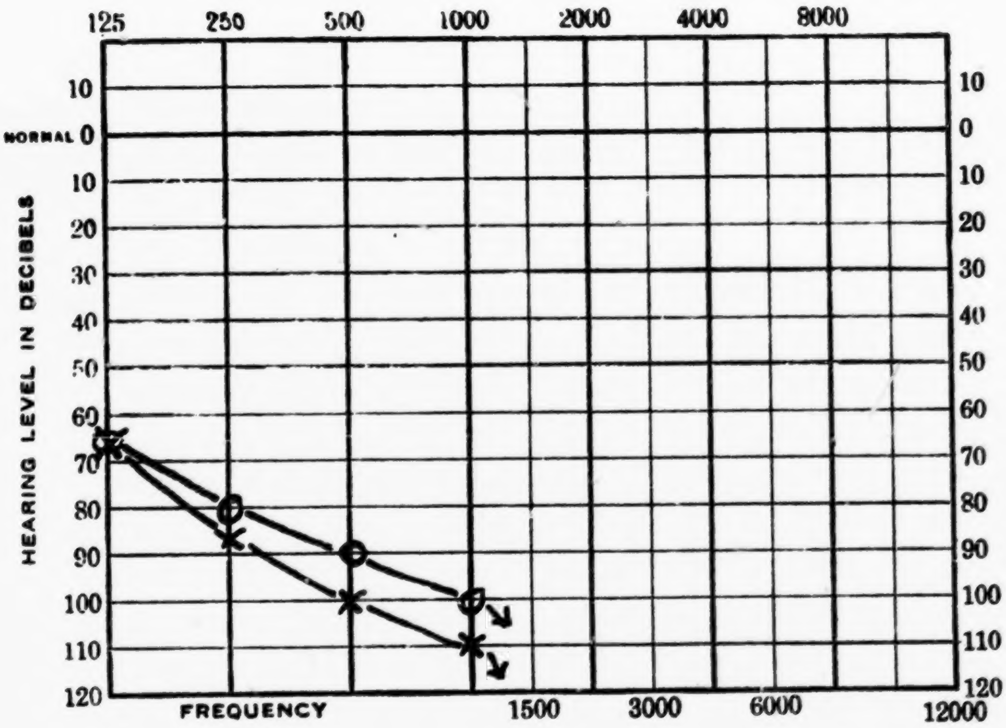
The following changes were observed in Ruth's speech during the experimental period: reduction of distortions of [ɑ] [ɛ] [o] and [ɔ], correction of distortion of [i], reduction of addition of extra vowels following [u] in words and reduction of distortion of speech rhythm. No change was observed in [æ]. Ruth was generally able to control her pitch level by monitoring it visually while phonating an isolated [u].

Sarah Vowel Group C.A. 8-5

Family and Environment

Sarah is the youngest of six children and the first girl after a succession of three normally hearing boys. Of her 17 year old twin sisters, one is deaf and commutes with Sarah to the school for the deaf, where they board during the week. The family lives in a small town about one hour from Boston. Sarah's father works in a supervisory capacity on the afternoon shift for a light manufacturing firm. Her father's mother, who is quite elderly and infirm, lives with the family.

Audiogram



History of Deafness

Sarah's deafness has been attributed to a series of colds and frequent ear aches in infancy, coupled with possible, inherited susceptibility to VIIIth nerve damage. Her sister was apparently born without hearing.

Response to Environmental Auditory Stimuli

Sarah responds to very loud sounds only.

Health and Physical Status

Sarah's development has progressed normally. Outside of a series of colds and ear aches in infancy which necessitated removal of tonsils and adenoids at one year and apparently caused her deafness, her health has been good. Though she appears to be a rather delicate child, she is well built and in sound physical condition.

Visual Acuity

Sarah is quite near-sighted, and though she has glasses to correct her vision, she wears them only during the week while in school. According to her mother, the doctor could only "guess at" the correct prescription for Sarah.

Visual Perception

Sarah's z scores on the *Ayres* and the *Frostig* were 38 and 2 respectively. Her combined group rank on the two tests was 18.

Intellectual Functioning

The following test results are recorded in Sarah's school folder:

Goodenough Draw-a-Man		Gesell Drawing Test	
C.A.	4-5	C.A.	4-5
M.A.	4-3	M.A.	4-0
I.Q.	96	I.Q.	91

The impression of Sarah's present teacher is that she is functioning below average intellectually and that she quite often has difficulty learning.

Education

Sarah was tutored for two years, one hour per week at a local hearing league, prior to her entrance at school at four years of age. Her mother reports that during this initial tutoring period of two years, she developed no speech (no words). Now in her fifth year at the school for the deaf, and having repeated a year in pre-school, she is in a grade 1A class for children who have difficulty learning.

Communicative Behavior - parent's report

At home, Sarah communicates primarily through gestures.

Communicative Behavior - teacher's report

It is the impression of her teacher that Sarah is functioning below average in written and spoken language.

Psycho-Social Behavior - parent's report

Sarah's parents see her as quite a spirited, lively little girl. On week ends, she enjoys writing, and going over her papers in school. She has one playmate, hearing, with whom she spends much of her time while she is at home.

Psycho-Social Behavior - teacher's report

Her teacher reports that Sarah shows no maladjustive behavior in school. She is cooperative and pleasant, though she is quite slow in academic work.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Sarah's voice was monotonous and weak. Initial observation of her speech revealed that all vowels when spoken in words were distorted. All consonants were either distorted or omitted.

Observations of Behavior during Sessions

Sarah was extremely quiet during sessions with the research teacher, not only vocally but in her whole manner. She appeared to be inhibited and communicated very little even in gestures and facial expression. She appeared to be quite dependent upon teacher approval. Her passivity was evident in her initial reaction to the Voice Visualzer - rather than experimenting with the machine by initiating sounds herself or by simply repeating sounds suggested by the research teacher, she seemed content to wait for and watch the screen for patterns of ambiant noise. It is possible also that this behavior indicated her inability to comprehend that she could control, by producing a sound, what appeared on the screen. Several sessions elapsed before Sarah seemed to grasp the relationship between the phoneme in print and the phoneme pattern on the Visualizer screen, and it was necessary to devote two full sessions initially to visual discrimination of elements and simple syllables. In her later performance with the Visualizer, she generally watched the screen, when encouraged to do so, but did not appear to monitor her speech.

Observations of Changes in Sarah's Speech

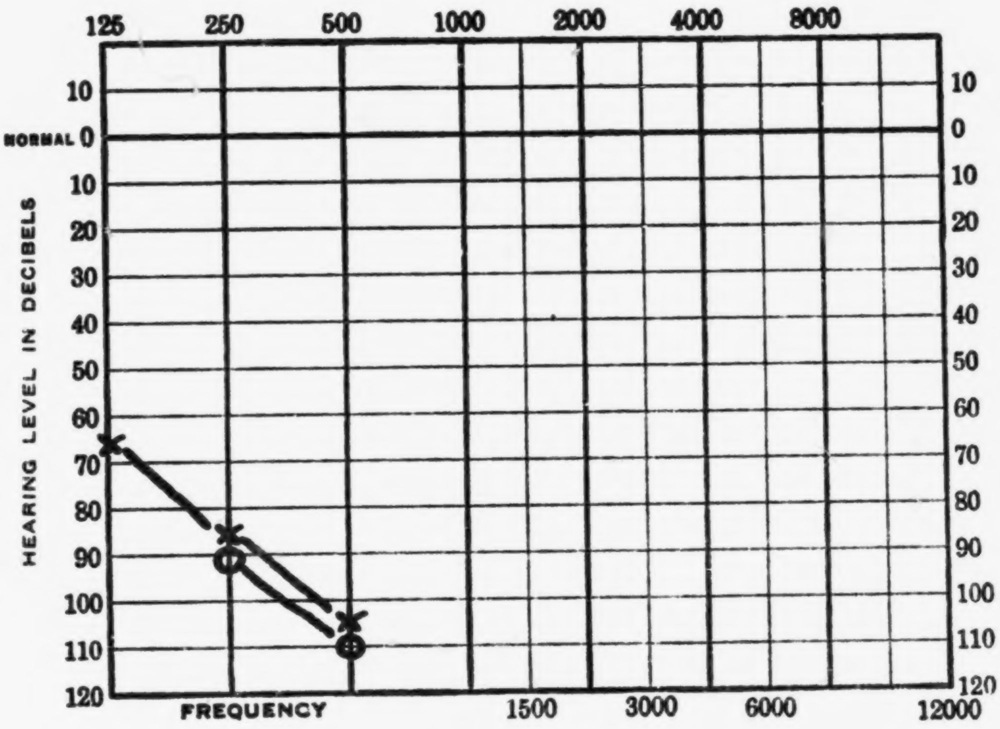
Observed in Sarah's speech during the experimental period were reductions of the distortions of [o] and [æ]. Observed also were reductions in distortions of [ɑ] [u] and [ɛ] but performance on these sounds was very inconsistent. No change was observed in [i] or [ɔ].

Tracy Vowel Group C.A. 8-5

Family and Environment

Tracy is the second of four children, three of whom are deaf. She boards at the school for the deaf during the week, along with her two deaf siblings, and travels to her home every weekend. Tracy's father is a salesman. In addition to her parents and siblings, her paternal grandfather also lives in the home.

Audiogram



History of Deafness

Tracy was apparently born deaf. Etiology of her deafness is unknown. Her hearing loss was first suspected when she was three months old.

Response to Environmental Auditory Stimuli

Her teacher reports that Tracy responds to loud sounds and can discriminate gross sounds.

Health and Physical Status

Other than a severe case of measles at 2 years of age, Tracy has had no major illnesses. Her physical development has progressed at a normal rate, she is in sound physical condition.

Visual Perception

Tracy's scores on the Ayres and the Frostig tests were 73 and 30 respectively. Her combined group rank was 7.

Intellectual Functioning

Test results recorded in Tracy's school folder indicate that at C.A. 5-8, she was functioning above average intellectually.

Pre-School Battery	Gesell Drawing Test	Goodenough Draw-a-Man
C.A. 5-8	C.A. 5-8	C.A. 5-8
M.A. 6-6	M.A. 7+	M.A. 6-6
	I.Q. 123	I.Q. 123

Her performance in school has been average, and it is the impression of her teacher that she is presently functioning on an average level intellectually.

Education

Tracy received speech therapy one-half hour weekly for an accumulated period of approximately two years at a local rehabilitation center. She had some auditory training at C.A. 1-8, when she received her first hearing aid, but the bulk of the therapy was carried on when she was 3-4 years old. She was enrolled in the school for the deaf at C.A. 5-3. Now in her fourth year there, she is in grade IA.

Communicative Behavior - parent's report

At home Tracy communicates in short phrases and gestures supplemented by writing when needed as a last resort. She shows an interest in wanting to speak well and is willing to speak slowly and carefully. Tracy has recently begun reading children's books. She is generally able to handle her school workbook materials easily at home.

Communicative Behavior - teacher's report

It is the impression of Tracy's present teacher that she is functioning on an average level in all verbal language skills.

Psycho-Social Behavior - parent's report

At home, Tracy enjoys activities typical for a girl of her age, and according to her mother shows no unusual behavior.

When home from school on week ends, she spends most of her leisure time with her family.

Psycho-Social Behavior - teacher's report

According to her teacher, Tracy shows no maladjustive behavior in school. She is an active, outgoing child.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Tracy's voice was loud, and was distorted by harshness and abrupt changes of pitch. Her speech rhythm was fairly good. Though most of her vowels and consonants were distorted in words, her speech was fairly intelligible in relation to the others in the vowel group. Distortion was observed in her voice quality in all vowels and, in particular, in the articulation of [ɛ] [i] [ɔ] and [æ].

Observations of Behavior during Sessions

Though Tracy often seemed restless and fidgety and was always lively during sessions with the Visualizer, her attention was generally very good. Communication with the research teacher was carried on almost entirely through speech and lipreading. Tracy's speech was often intelligible to the research teacher without additional clues.

Tracy was among the most able in the vowel group at visually monitoring her speech; and because she offered a great deal of spontaneous language, many opportunities arose to monitor speech which was particularly meaningful to her. She was also very adept at visual discrimination. The extreme intensity of Tracy's voice produced peculiar distortions of the Visualizer patterns which she learned to recognize and use to monitor her vocal intensity.

Observations of Changes in Tracy's Speech

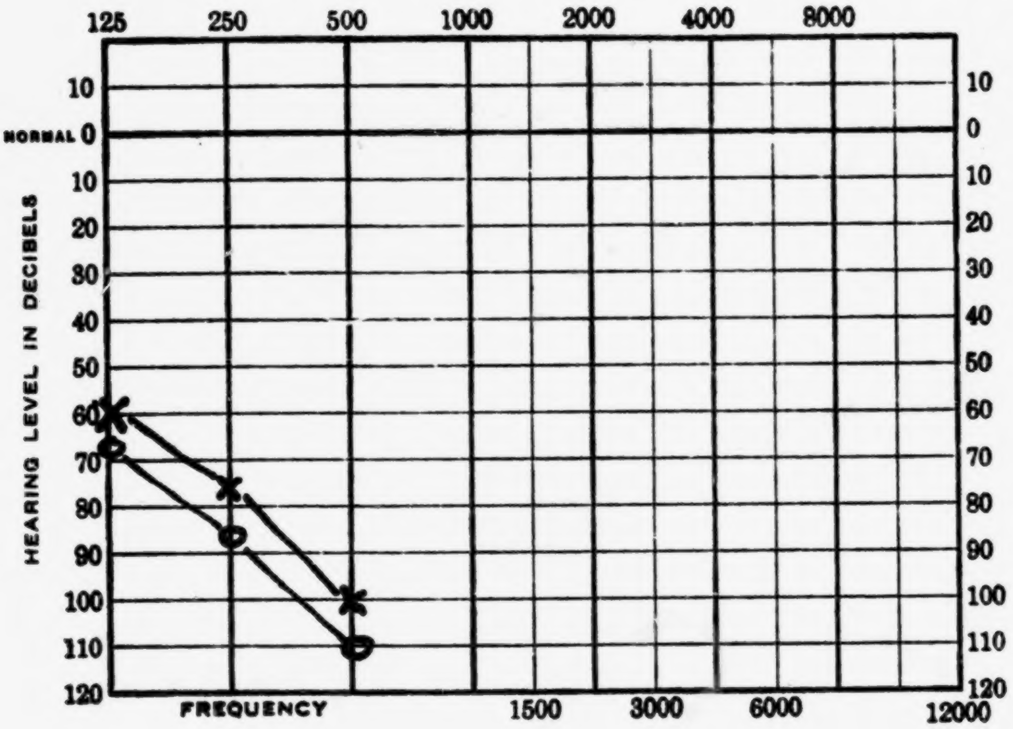
The following changes were observed in Tracy's speech during the experimental period: correction of distortions of [i] [ɛ], and reduction of distortions in [o] [ɑ] [ɔ] [æ] and [u]. Also observed was a general reduction of the intensity and of the distortion in her voice.

Ursula Vowel Group C.A. 8-7

Family and Environment

Ursula is one of nine children ranging in age from 1 1/2 to 15 years. She has an identical twin sister who has normal hearing. Her father, a skilled laborer, is able to support the family on his own. They live in a well cared for, four bedroom house in a lower middle class urban area. Ursula is the only member of her family who is deaf.

Audiogram



Histoty of Deafness

Ursula was born with normal hearing, and developed speech normally until the age of 14 months when she contracted encephalitis. The virus left her profoundly deaf.

Response to Environmental Auditory Stimuli

She responds to loud sounds only.

Health and Physical Status

Following her illness, it was necessary for her to relearn how to sit up, to stand, and to walk alone. Her mother reports that she was stubbornly determined to do whatever her twin did, and within a period of several months, and after numerous falls and bumps, she attained her previous level of motor development. She is now in good health and sound physical condition. She enjoys many sports, particularly swimming, and is quite athletic.

Visual Perception

Ursula was evaluated by a psychologist at C.A. 4-1 whose impression it was that she showed no evidence of difficulty in visual motor or visual perception tasks. Ursula's z scores on the Ayres and the Frostig were 74 and 3 respectively. Her combined group rank on the two tests was 17.

Intellectual Functioning

The impression of the psychologist who evaluated her at C.A. 4-1 was that Ursula was operating at a level of at least good normal intellectual functioning. It is the impression of Ursula's present teacher that she is functioning on an average level intellectually, but, with respect to the teacher's present class, that Ursula's intellectual potential is above average.

Education

Ursula was enrolled in the school for the deaf at C.A. 6-4. Now in her third year in school, she is in a grade IA class for children who have difficulty learning.

Communicative Behavior - parent's report

She communicates primarily through gestures at home. She uses her voice when gesturing, but not always for speaking words. She can always make herself understood; if need be, she draws or writes what she is attempting to express. She loves to write and on occasion has saved her allowance in order to buy paper.

Communicative Behavior - teacher's report

It is the impression of Ursula's teacher that she is functioning on an average level in all aspects of verbal communication.

Psycho-Social Behavior - parent's report

Her mother reports that Ursula is a normally active little girl, somewhat inclined to be spoiled by well-meaning relatives and friends who feel sorry for her. Her mother works at maintaining the equality in the attention shown, and the discipline given Ursula and her twin sister. Ursula and her sister play every day after supper at a neighborhood playground with hearing children.

Pyscho-Social Behavior - teacher's report

When Ursula was 2-10 and again when she was 4-1, she was evaluated by a psychologist who found her on both occasions to be quite resistant and generally uncooperative. It is the impression of her present teacher that Ursula is now generally cooperative, and, with respect to her classmates, is one of the two pupils with the best mental health.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Ursula's voice was weak, breathy and monotonous, and was varied only by occasional, uncontrolled and abrupt changes of pitch. All vowels were distorted and most consonants were either distorted or omitted.

Observations of Behavior during Sessions

Ursula was shy and self-conscious and generally quite dependent on reinforcement from the research teacher. After several weeks of practice with the Visualizer, she seemed to relax somewhat and began to initiate conversation about the picture materials. She was cooperative and generally attentive to the Visualizer patterns, though she appeared unable to change her vowel patterns to any considerable degree. Ursula's speech was unintelligible without additional visual clues. Her vocabulary was limited and her lipreading ability was only fair.

Observations of Changes in Ursula's Speech

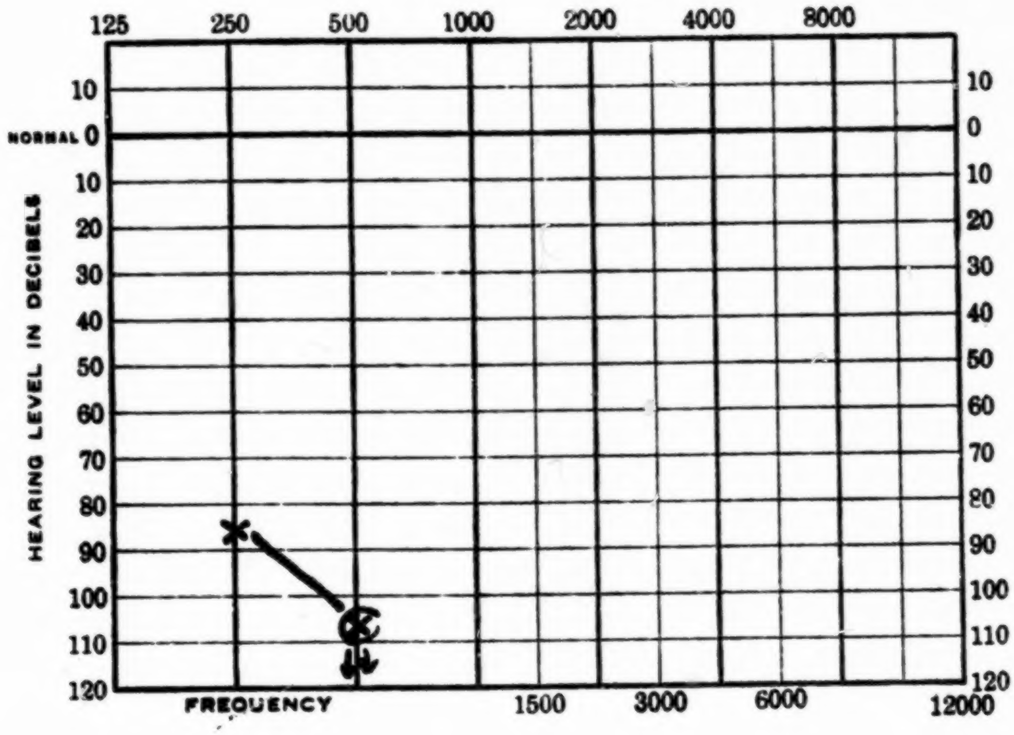
Observed in her speech during the experimental period were reductions in the distortions of [i] [ɑ] and [o]. Reduction of the distortion of [u] was observed to be considerable at times but was highly inconsistent. No change was observed in [æ] [ɔ] or [ɛ].

Victor   Vowel Group   C.A. 8-8

Family and Environment

Victor lives with his mother and 12 year old hearing sister in one of a complex of small apartments in a lower-middle income residential area. Victor's mother works during school hours; his father is a laborer.

Audiogram



History of Deafness

The cause of Victor's deafness is not known definitely. While in the third month of pregnancy, his mother had an appendectomy under a spinal anesthetic; while in the ninth month, she fell, injuring the uterus and apparently caused a prolonged labor; three months after her birth, Victor may have had measles. Any or none of these conditions may have contributed to the child's hearing loss. Deafness was first suspected when Victor was 13 months old.

Response to Environmental Auditory Stimuli

Victor does not respond to any but very loud sounds. His mother believes he hears nothing at all, but that he feels the vibration caused by loud, low noises.

Health and Physical Status

Victor was born, apparently normal, after a prolonged labor. At the age of 13 months, his parents, suspecting that he was deaf, took him to a hospital clinic for hearing testing. There, they learned thus quite by accident that the child was suffering from lead poisoning and very ill. He was placed in the hospital and recovered. Victor's mother explains that because of this incident, she has always "thought of his deafness as a blessing in disguise." Outside of his hearing impairment, his physical and mental development has progressed normally. He is an unusually handsome child, well-built and agile. Outside of frequent and severe episodes of ear ache and ear infection during his second and fourth years and lead poisoning at one year, he has been in good health.

Visual Perception

His z scores on the Ayres and the Frostig were 78 and 9 respectively. His combined group rank was 14.

Intellectual Functioning

Results of psychological tests administered to Victor when he was 4 1/2, along with his present teacher's impression, indicate that he is functioning within the normal range intellectually.

Goodenough Draw-a-Man		(second trial)		Gesell Drawing Test	
C.A.	4-8	C. A.	4-8	C.A.	4-8
M.A.	4-6	M.A.	5-0	M.A.	5-0
I.Q.	97	I. Q.	111	I.Q.	111

Education

When he was four years old, he entered the school for the deaf. He spent the first two years in the pre-school program, but since then, has been promoted regularly and is now, in his fifth year in school, in grade 2.

Communicative Behavior - parent's report

At home, Victor expresses himself primarily through gestures. He usually does not use his voice to speak, but mouths words as he is gesturing.

Communicative Behavior - teacher's report

The impression of Victor's teacher is that he is functioning at an average level generally in verbal language usage and comprehension, but that he is above average in comprehension of written individual vocabulary (individual words).

Psycho-Social Behavior - parent's report

Victor is an outgoing child, unafraid of talking to people whom he does not know. In his neighborhood, he is shunned by the children of his own age, but is accepted by, and plays well with younger children, 4 and 5 years old. His mother is somewhat concerned that he is rejected by his hearing peers, but seems to be pleased with the relationships he has with the younger neighborhood children.

Psycho-Social Behavior - teacher's report

Victor's teacher reports that he shows no maladjustive behavior; she feels he is a good-natured child who makes an effort to do well in school.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Victor's voice was marked by abrupt and uncontrolled changes of pitch. In connected speech, rhythm was poor. Most of his vowels were distorted to some extent, including [i] [a] [o] [ɛ] [ɔ] [æ] and to a lesser degree, [u]. Most of his consonants were either distorted or omitted.

Observations of Behavior during Sessions

Victor had little difficulty making himself understood to the research teacher though his command of verbal language was fairly poor. His use of facial expression and gesture was subtle and exact. He was alert, quick to perceive any change in the situation, and to understand what was being asked of him. His speech, except for a few isolated words, was unintelligible without the use of some additional visual clue. He appeared to be a self-confident, happy boy who has made a good adjustment to his handicap. He was interested in the Visualizer and seemed motivated to do well with it, though his attention appeared to decrease as the program progressed.

Observations of Changes in Victor's Speech

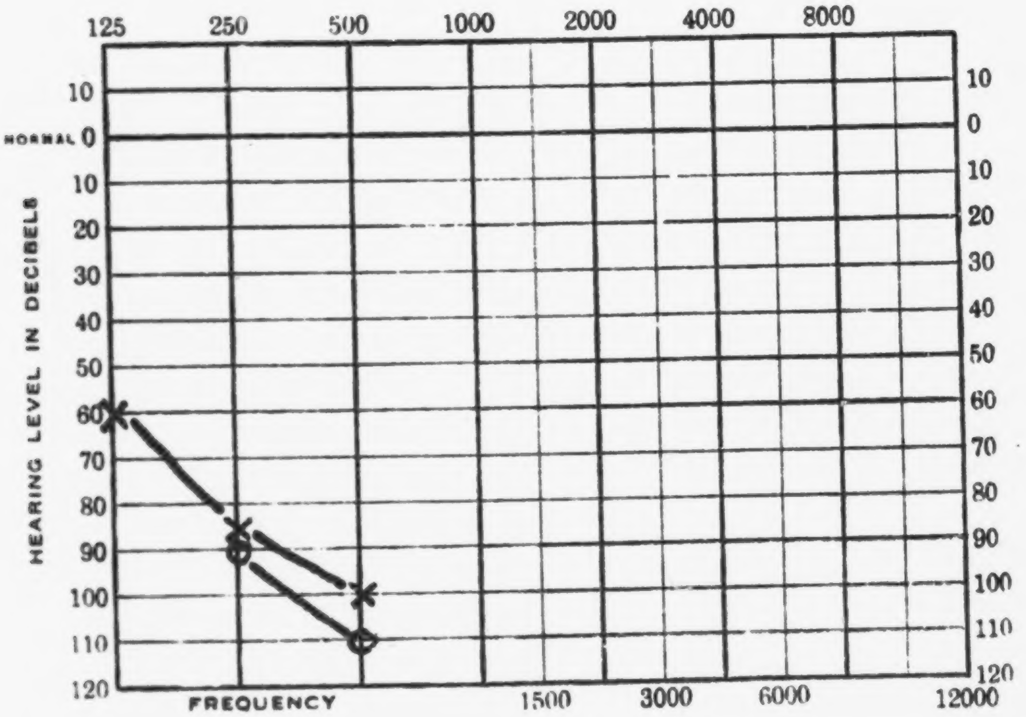
The following changes were observed in Victor's speech during the experimental period: reduction of distortion in pitch level, reduction of distortions of [u] [o] [ɛ] and [ɑ] and reduction of omissions and distortions of [θ] [t] [f] and [m]. Reduction of the distortion of [i] was observed but very inconsistently. No change was observed in [æ].

Wayne   Vowel Group   C.A. 8-11

Family and Environment

One of six children, Wayne has both older and younger sisters and brothers, all of whom have normal hearing. The family lives in a large modern house in a quiet suburban area about 20 miles from Boston.

Audiogram



History of Deafness

Apparent cause of deafness was rubella contracted by Wayne's mother while she was in the third month of pregnancy.

Response to Environmental Auditory Stimuli

Wayne only responds to very loud sounds.

Health and Physical Status

He is in good health. He was hospitalized once for removal of his adenoids.

Visual Perception

Wayne's scores on the Ayres and the Frostig were 88 and 1 respectively. His combined group rank was 13.

Intellectual Functioning

He repeated a year in preparatory and in a year in preschool. He is presently in a class for children who have difficulty learning.

Education

Wayne entered the school for the deaf at C.A. 3-8. Now in his sixth year in school, he is in grade 1A.

Communiative Behavior - parent's report

At home, he relies primarily upon gestures to communicate, but is beginning to use his voice to a greater extent.

Communicative Behavior - teacher's report

His teacher reports that he is functioning on an average level in language, both receptively and expressively.

Psycho-Social Behavior - parent's report

Wayne's mother feels that he is the most active of all her children. He likes all outdoor, "boyish" activities and is a bit of a daredevil.

Psycho-Social Behavior - teacher's report

Wayne's teacher reports that he shows no maladjustive behavior. He is an active, outgoing boy, and is cooperative in school.

Clinical Report of Observed Speech and Behavior Patterns

Initial Observations of Speech and Voice

Wayne's voice was weak but tense. Speech rhythm and inflection, when he was communicating, were generally good. All his vowels were distorted to some degree and most consonants were distorted or omitted.

Observations of Behavior during Sessions

Wayne was lively and cooperative during sessions, and he seemed to enjoy using the Visualizer throughout the whole experimental period. When he spoke slowly, individual words in his speech were intelligible. He was interested in the materials and often initiated conversation relating to them. Wayne was generally very attentive and often monitored his speech completely on his own without reinforcement from the research teacher.

Observations of Changes in Wayne's Speech

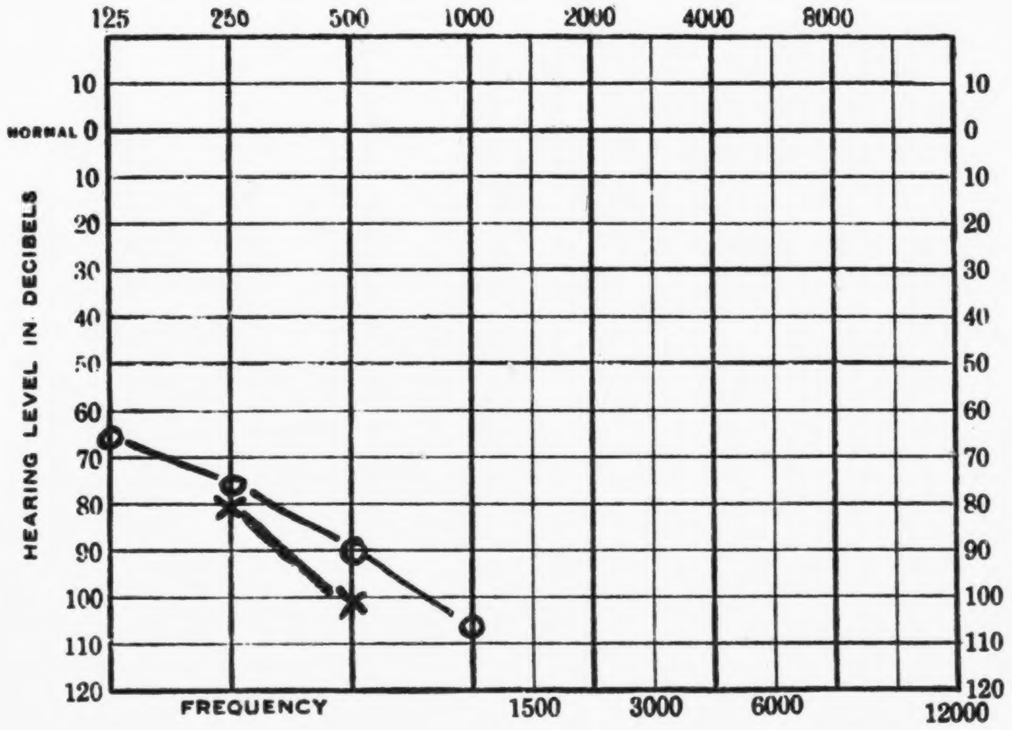
The following changes were observed in Wayne's speech during the experimental period: reduction of distortions of [i] [ɑ] [ɛ] [u] [o] [ɔ] and [æ], reduction of addition of [ʌ] after the final [p] or [t] in words, increase in vocal intensity, reduction of omission of plosives, and reduction of omissions of [s] and [f]. In general, an increase in Wayne's vocal intensity produced reduction of vowel distortion.

Yvonne Vowel Group C.A. 9-6

Family and Environment

Yvonne is the youngest of four children all of whom are fairly close in age. Her parents and siblings have normal hearing. She lives in a modest frame house on a quiet, residential street in greater Boston. Her father is the assistant chief engineer for a small municipal operation.

Audiogram



History of Deafness

The cause of Yvonne's deafness is uncertain, though it is possibly related to medication given her mother prior to pregnancy, and/or high fever the child developed shortly after birth. Deafness was suspected by her parents when she was 3 months old.

Response to Environmental Auditory Stimuli

Her mother reports that at home, Yvonne responds to no sound.

Health and Physical Status

Yvonne was delivered by Caesarean section. The birth was normal, but the child developed a high fever shortly after, and upon release from the hospital at 14 days, and she had blisters on her body. She had no control of her limbs or head, until the age of 7 months, but the age of 10 months, she was able to sit alone, and by 18 months, to walk alone. Her mother reports that as a very young child she had frequent stomach upsets, and from the age of one month to two years, she registered disapproval by vomiting. She is an obese child.

Visual Acuity

Yvonne is far-sighted and has an astigmation in her right eye. She wears glasses to correct her vision.

Visual Perception

Her z scores on the Ayres and the Frostig were 86 and 15 respectively. Her combined group rank was 8.

Intellectual Functioning

At C.A. 2-4, Yvonne was evaluated by a neurologist who found her to have a short attention span, but to have no apparent neurological defect. At C.A. 3-0, she was evaluated by a psychologist whose impression it was that she was developing slowly but within normal limits of intellectual functioning. The following scores are recorded in her school folder:

Goodenough Draw-a-Man		Gesell Drawing Test	
C.A.	5-6	C.A.	5-6
M.A.	5-9	M.A.	5-6
I.Q.	106	I.Q.	100

Her present teacher feels that Yvonne is functioning on an average level intellectually. However, her record of performance in school indicates that she is functioning below average academically particularly in language skills.

Education

When she was three years old, Yvonne was tutored for more than two months by a clinical teacher of the deaf. At C.A. 4-3, she entered the school for the deaf. Now in her sixth year in school, she is in grade 2.

Communicative Behavior - parent's report

Her mother reports that Yvonne prefers communicating by gestures, although she does often supplement her gesture language with one word phrases.

Communicative Behavior - teacher's report

Yvonne's first tutor reported that she was not interested in vocalizing or imitating speech or in watching the face for lipreading. Yvonne was observed to build up devices to avoid vocalizing and watching and became difficult to manage when forced. According to her present teacher, she is functioning on a level above average in lipreading, speaking and writing and on an average level in reading.

Psycho-Social Behavior - parent's and others' report

Yvonne's mother reports that she likes to stay around the house after school and on week ends. She has one friend (hearing) in the neighborhood and since last year has been allowed to cross the street by herself to visit her. The bus driver who takes Yvonne home from school reports that her mother is waiting by the door every day as he drives up, and always comes out to help Yvonne from the bus to her house.

Psycho-Social Behavior - teacher's report

According to her present teacher, Yvonne shows no maladjustive behavior. She is quiet, unassuming and very cooperative in school.

Clinical Report of Speech and Behavior Patterns

Initial Observations of Speech and Voice

Yvonne's voice was high-pitched, tense and weak. All sounds except [b] and [ʌ] were distorted in words. Generally, her speech consisted of undifferentiated, voiced glottal stops.

Observations of Behavior during Sessions

Yvonne was quiet and cooperative during sessions, but seemed to have great difficulty focusing her attention on the Visualizer screen. She often"said" she understood directions when her performance indicated the contrary. She was able to lipread simple words in highly structured situations, but showed little or no lipreading ability in communicative situations even when the language was extremely simple. Without additional clues, her speech was entirely unintelligible to the research teacher. She indicated no understanding of the concept of articulating several phonemes in succession to produce one syllable. Communication between Yvonne and the research teacher was minimal. Yvonne seemed to want to express herself, but her vocalizations and gestures seemed flights of fancy and conveyed little or no meaning to the research teacher.

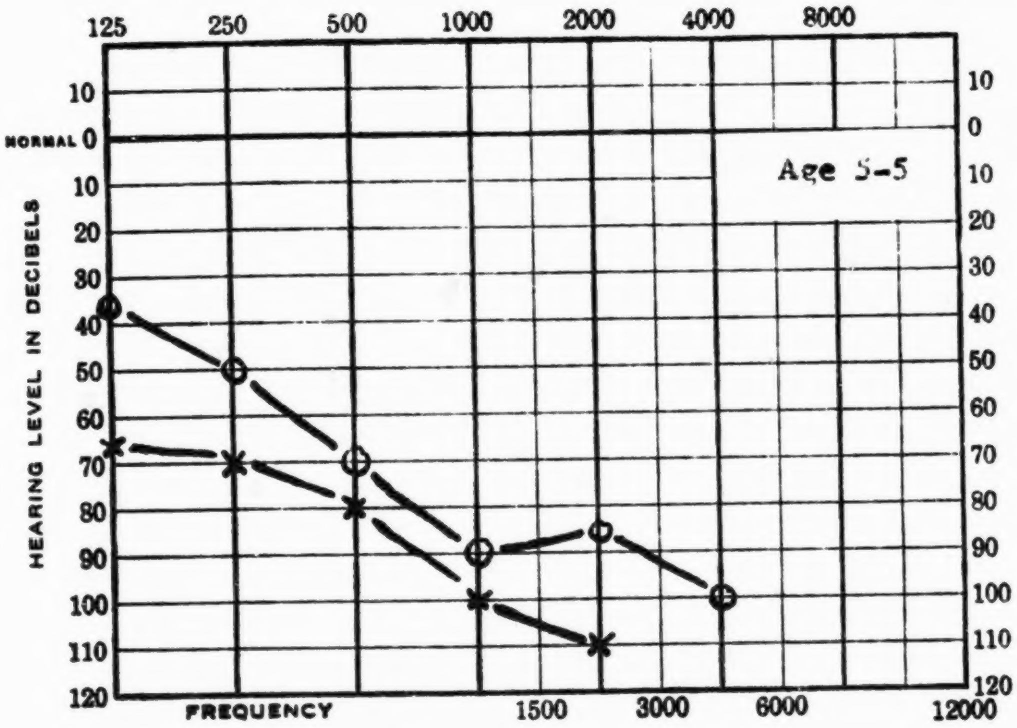
Observations of Changes in Yvonne's Speech

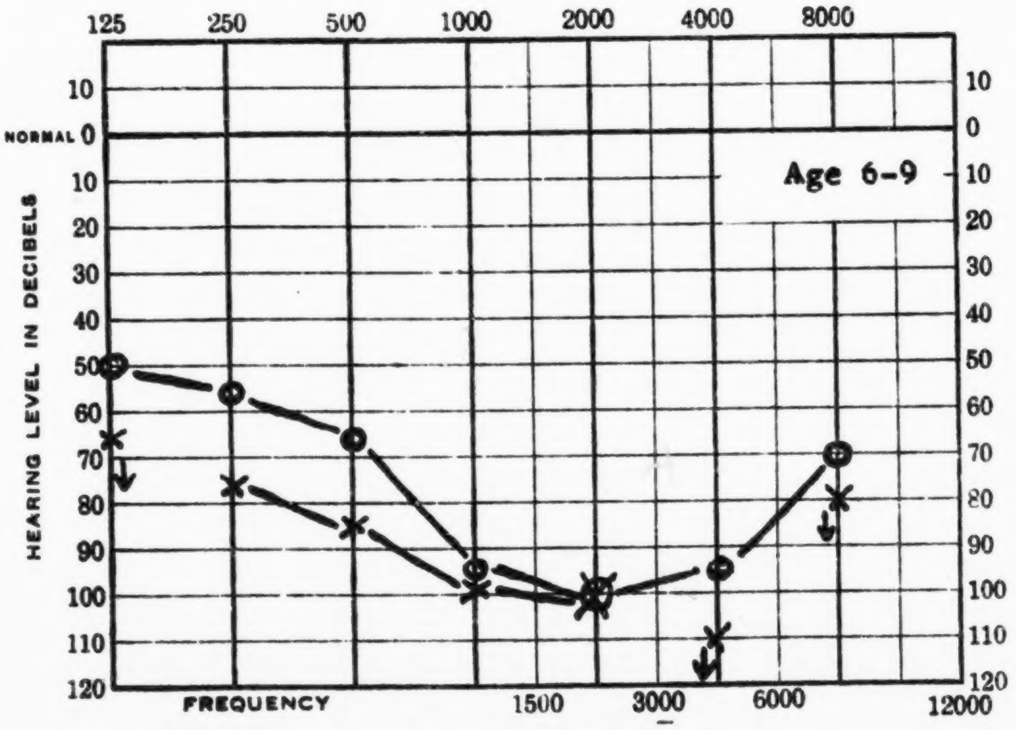
The following changes were observed in Yvonne's speech during the experimental period: reduction of nasality in some vowels, particularly [i], reduction of distortion of pitch level, and reduction of distortions of [ɑ] [u] [ɛ] and [æ]. Reduction of distortion of [i] was observed but not maintained. No change was observed in [ɔ] or [o]. Yvonne apparently had difficulty maintaining differences between sounds. When practicing the paired words, her approximation of the two vowels were at times closer to one of the vowels, at times closer to the other.

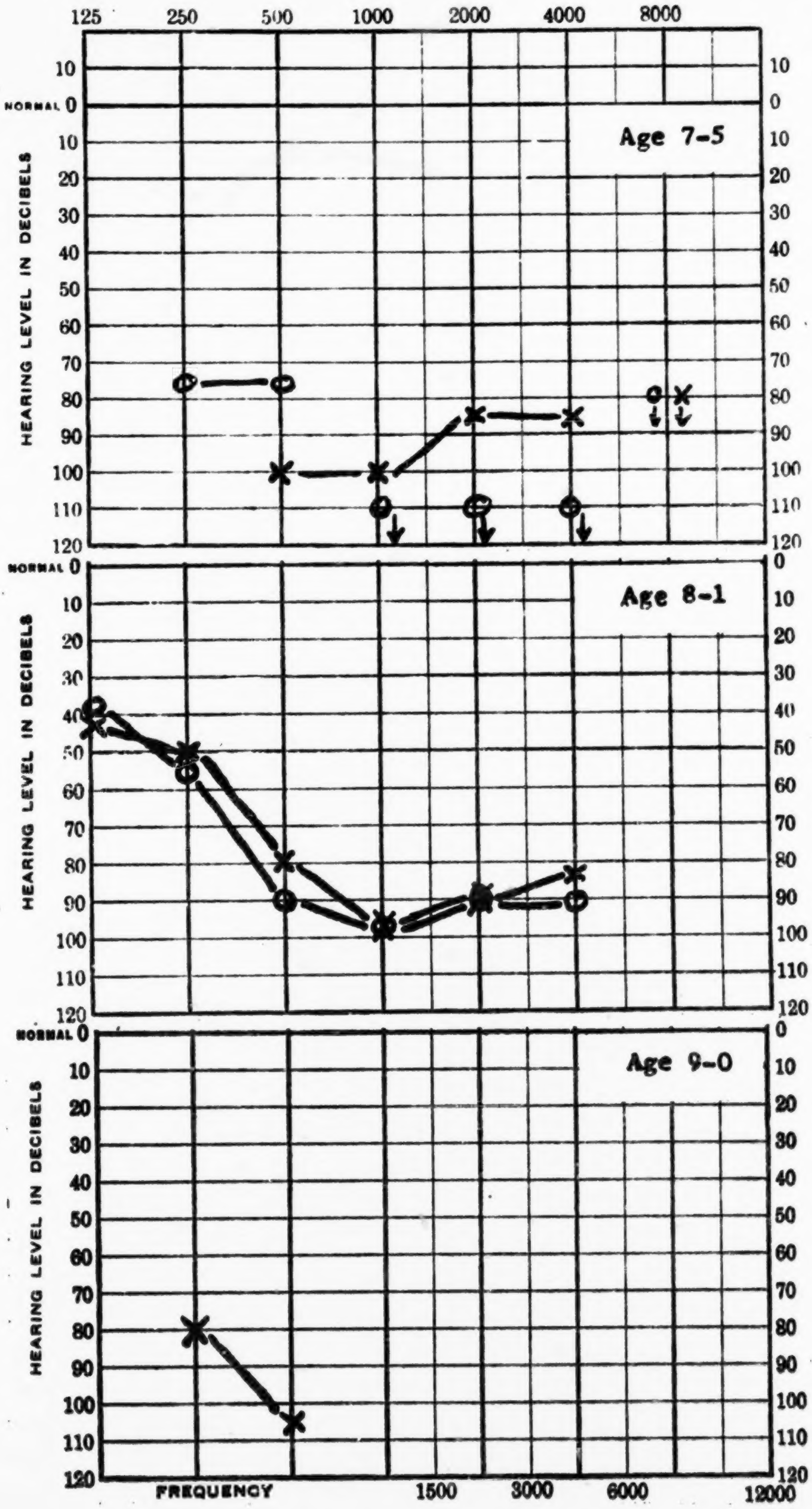
APPENDIX E

"Advanced Speakers" Group

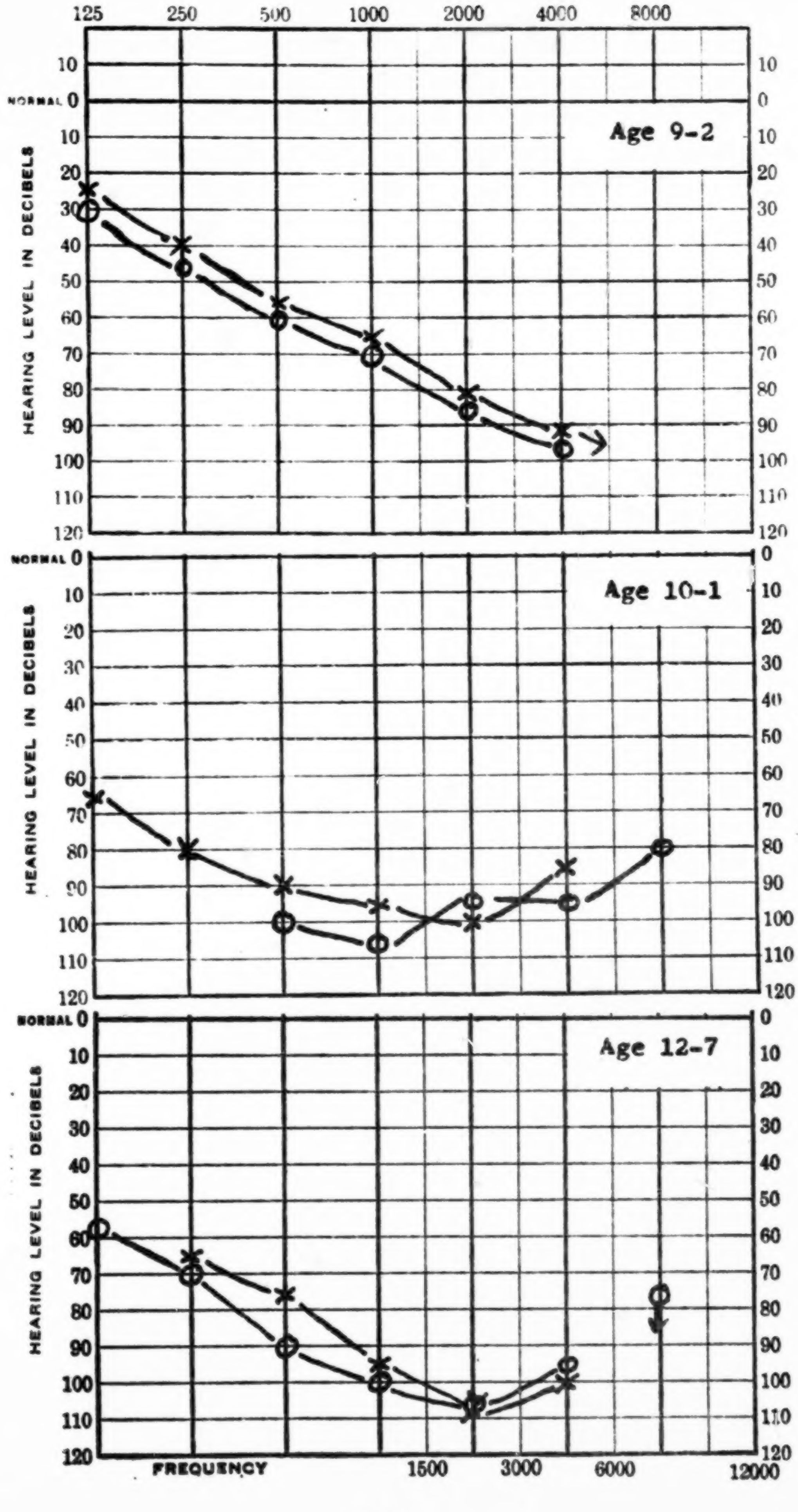
Audiograms:







125 250 500 1000 2000 4000 8000
NORMAL 0
HEARING LEVEL IN DECIBELS
10 20 30 40 50 60 70 80 90 100 110 120
Age 7-5
Age 8-1
Age 9-0
FREQUENCY
1500 3000 6000 12000


125
250
500
1000
2000
4000
8000
NORMAL
HEARING LEVEL IN DECIBELS
10
0
10
20
30
40
50
60
70
80
90
100
110
120
Age 9-2
Age 10-1
Age 12-7
FREQUENCY
1500
3000
6000
12000

Reports of Observed Speech and Behavior Patterns

Child 1 -- C.A. 5-5 In the first recording of this child's speech, prior to instruction with the Voice Visualizer, the following distortions were observed: substitution of [f/v], distortions of [θ] and [ð], and occasional omissions or distortions of [s] [z] and final consonants. Voice quality, inflection and speech rhythm were normal. The child was able to imitate exactly the research teacher's intonation in words and phrases, indicating excellent use of residual hearing. In the first two sessions, she seemed a little bewildered by the Visualizer patterns and the task of monitoring, but in the last two sessions, she appeared to understand quite well. She was somewhat shy and hesitant about responding and appeared to tire easily. During sessions with the Visualizer the following changes were observed in her speech: substantial reduction in the omissions of [s] and [z], reduction in the distortions of [s] [z] and [v], and increase in the frictional component in [θ] in final positions.

Child 2 -- C.A. 6-9 Prior to working with the Visualizer, this child presented the following distortions in his speech: substitution of [f/v], insufficiency of nasal resonance in [m] and friction in [f], omissions or distortions of [s] and [z]. His voice quality was natural, and his vowels were generally not distorted. Quite lively and talkative, he demonstrated a natural flow of spoken language. When concentrating on his speech, he tended to prolong all sounds and thus had difficulty learning to prolong only one sound in each word. He was cooperative and attentive, but often depended upon reinforcement from the research teacher. The following changes were noted in his speech during sessions with the Visualizer: reduction in the distortions and omissions of [s] and [z], reduction in the distortion of [v], and increase in the frictional component and in the duration of [f].

Child 3 -- C.A. 7-5 Prior to instruction with the Voice Visualizer, the following distortions were observed in this child's speech: omissions or distortions of [s] and [z], distortions of [f] [v] [θ] [r] and [u], and substitution of [g/l]. Her voice was harsh, strained and breathy, and her production of vowels was inconsistent. Having developed speech normally until last year when she lost her hearing, she showed ability in expressive language nearly comparable with normally hearing children, though her lipreading ability was far below that of her deaf peers. She was very active during sessions with the Visualizer, and appeared to crave affection, as well as the approval of the research teacher. Her attention to the Visualizer screen was only fair, but she seemed to make an effort to perform well in order to gain approval. The following changes were noted in her speech during the period of instruction: correction of the distortions of [s] [z] [f] [r] [l], reduction of the distortions of [v] and [u]. When she was encouraged to relax, her voice quality and vowel articulation improved.

Child 4 -- C.A. 8-1 Before instruction with the *Voice Visualizer*, the following distortions were observed in this child's speech: substitutions of [f/v] and [tʃ/ʃ], substitutions of [t/s] or [ts/s] and [s/z] or omissions of [s] and [z], insufficiency in friction in [θ] and [f] and distortion of [r]. Her voice was pleasant, but many of her vowels were slightly distorted and many of her phonemes, prolonged. She was generally quiet and cooperative during the teaching sessions, but she did not monitor her speech unless her errors were first pointed out by the research teacher. She found production of simultaneous voice and friction in [v] and [z] very difficult and succeeded only with much effort and concentration. The following changes were noted in her speech during the two week experimental period: reduction of the distortions in [f] [s] and [θ], and addition of voice in [v]. No change was observed in her production of [z] or [ʃ]. Though she became aware of the visual difference between [t] and [s], the degree of confusion between them remained unchanged.

Child 5 -- C.A. 9-0 The following distortions were noted in this child's speech prior to instruction with the *Voice Visualizer*: substitution of [b/m], distortion of [r], omissions of [s] and [z] or substitutions of [ts/s] or [ts/z], omissions of [v] and [m] in final positions and omissions of most stops. Her voice was high-pitched, but though voice quality was distorted, most of her vowels were intelligible. Speech rhythm was fairly natural. She had no difficulty understanding the concept of visual monitoring but rarely monitored without some reinforcement from the research teacher. She seemed to enjoy herself while working with the Visualizer. During the teaching sessions, the following changes in her speech were noted: reduction of substitutions of [b/m] and [ts/s], addition of voice and friction in [v], addition of friction in [r], and reduction in omissions of stops. No change was observed in [z].

Child 6 -- C.A. 9-2 Prior to working with the Visualizer, this child presented the following distortions in her speech: substitutions of [f/v] [w/r] and [s/z], confusions of [t] and [s], [ts] and [s] and occasional omissions of [s]. Her voice quality, inflection and speech rhythm were natural and her vowels correctly articulated. During sessions with the Visualizer, she was cooperative and interested, and she generally watched the screen carefully, monitoring her speech. The following changes in her speech were noted during the teaching sessions: reductions of omissions of [s] and confusions of [t] and [s], [ts] and [s], reductions in distortion of [r], and addition of voice in [v]. Very little change was observed in [z].

Child 7 -- C.A. 10-1 Prior to instruction with the *Voice Visualizer*, the following distortions were observed in this child's speech: substitutions of [f/v] [b/m], distortions of [f] [l] [r], confusions of [t] and [ts] with [s] and [z], and frequent omissions of [s] and [z]. His voice was a little harsh, but his vowels were intelligible. He was very attentive to the Visualizer patterns and frequently monitored his speech without reinforcement from the research teacher. During the experimental period, the following changes were noted in his speech: correction of the substitution of [b/m] and the distortion of [l], reduction in the confusions between [t] and [s], reduction of the omissions of [s] and [z], and addition of voice to [v] and [z]. No change was observed in [f] or [r].

Child 8 -- C.A. 12-7 The following distortions were noted in this child's speech prior to instruction with the Visualizer: omissions or distortions of [s] and [z], substitution of [f/v], and distortion of [ʃ]. Her voice was natural, and,quite talkative, she communicated entirely through speech and lipreading. She was cooperative and usually watched the Visualizer screen. During the sessions with the Voice Visualizer, the following changes were observed in her speech: correction of the distortion of [ʃ], addition of voice in [v] and [z], and reduction in the omissions of [s] and [z].

APPENDIX F

Test Words and Phrases

The test words and phrases were presented in printed form, with accompanying pictures for the test words, in the numerical order indicated.

Consonant Group

1. five
2. soup
3. name
4. fish
5. news
6. phone
7. leave
8. red
9. nun
10. boys
11. zoo
12. farm
13. gun
14. ice cream
15. knee
16. moon
17. please
18. long
19. rain
20. mouth
21. yes
22. have
23. milk
24. run
25. stove
26. ring
27. sick
28. man
29. give
30. laugh
31. no
32. school
33. green
34. leg
35. fork
36. shoes
37. come
38. ran
39. sun
40. love
41. rat
42. leaf

1. Give a fork to John.
2. The leaf is green and red.
3. Yes or no?
4. The man has red shoes and ring.
5. Run to school.
6. The boys are sick.
7. Please, may I have some ice cream?
8. There is milk on Betty's mouth.
9. The farm has five cows.
10. The boy has along fish and a gun.

Vowel Group

1. school
2. ten
3. fat
4. coke
5. arm
6. please
7. hot
8. blue
9. am
10. red
11. no
12. eat
13. moon
14. car
15. black
16. go
17. dress
18. me
19. two
20. boat
21. green
22. farm
23. bad
24. shoe
25. yes
26. home
27. top
28. feet
29. bed
30. cat

1. I see ten cars.
2. I see a black cat and the moon.
3. He is hot.
4. May I have a coke, please?
5. The girl hurt her arm.
6. I am seven years old.
7. Go to bed.
8. He sees a boat far far away.
9. The girl has on blue socks and red shoes.
10. Eat your green beans.

"Advanced Speakers" Group

The test words and phrases of the consonant group were used with the following substitutions:

Words -

3. eat (i)
9. two (u)
13. home (o)
15. arm (a)
31. bed (e)
33. car (a)
38. green (i)

Phrases -

11. Eat dinner at home (i,o)
12. I see two cars and a bed.

OE 6000 (REV. 9-66)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

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TITLE
The Development and Evaluation of Procedures for using
The Voice Visualizer as an aid in Teaching Speech to the Deaf

PERSONAL AUTHOR(S)
Pronovost, Wilbert and others

INSTITUTION (SOURCE)
Boston University, Boston, Massachusetts, School of Education

SOURCE CODE

REPORT/SERIES NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

PUB'L. DATE 08 – 31 – 67

CONTRACT/GRANT NUMBER OE-1-6-062017-1588

PAGINATION, ETC.
170

RETRIEVAL TERMS
Voice Visualizer
Visible Speech
Speech for Deaf
Visual Monitoring of Speech
Deaf - Visual Monitoring Equipment

IDENTIFIERS

ABSTRACT

The design of The Voice Visualizer, which presents visual patterns of vowels and consonants for self-monitoring of speech by deaf children, is described with circuit diagrams and photographs. A manual of teaching materials, for use in classroom or individualized teaching, is presented. Results of an experimental program with two groups of deaf children with "poor" speech, and an "advanced speaker's" group, are included. The experimental program was evaluated by listener judgments of tape recordings made before, during and after a four month period. All groups of children showed improvement in judged articulatory proficiency. For the vowel and consonant groups, the greatest improvement occured at the end of the first month of the experimental program. The consonant group improved more than the vowel group, but the judged improvement was not accompanied by a corresponding improvement in word intelligibility. The "advanced speaker's" group improved both in intelligibility and articulatory proficiency during a program of five sessions in a two and one-half week period. The Visualizer appears to be most effective in motivation of speech improvement for short periods of time, for refinement of vowel and consonant articulation, and with deaf children who have already developed a degree of articulatory proficiency.